DESIGN MANUAL
CITY OF BRUNSWICK

FREDERICK COUNTY, MARYLAND

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CITY OF BRUNSWICK
DESIGN MANUAL

I.0 GENERAL

A. Reference

All subsequent references to the City or City of Brunswick shall mean the Mayor and Council of Brunswick. Any references to other documents in this Manual shall mean the latest edition of that document.

B. Purpose and Objectives

This Design Manual is intended to provide the Developers and consulting engineering community with the City of Brunswick's requirements, references, standards and procedures. The Manual is intended to aid the designer during the preparation and presentation of engineering design for the City of Brunswick. The Design Manual was developed in cooperation with the Planning Commission, Mayor and Council, Office of Planning and Zoning, and the City's engineering and public works staff. It must be clearly understood that the criteria and/or requirements presented herein are considered by the City to be minimum requirements and that additional requirements may be enforced as the City deems appropriate on a case-by-case basis. In the event a conflict exists between requirements, the more stringent applies.

It is intended that the use of this Manual should help achieve the following objectives:

1. This Manual is intended to implement the general responsibility of City government to provide for the health, safety and general welfare of the populace.

2. Uniformity of Approach - The City desires its facilities to be designed with similar characteristics, configuration and features as much as is practical considering project requirements. It is hoped that this Manual will promote such uniformity.

3. Economy of Design and Schedule - By stating the City's requirements and preferences at the outset, we hope to eliminate costly false starts and schedule slippages caused by the need to redesign.

4. Technical Quality Improvement - It is hoped that, by setting forth the City's standards which reflect considerable experience, the overall quality of the design and construction will be improved.

5. Information - It is intended to eliminate unnecessary inefficiencies by answering designer's questions common to most designs.

C. Updates of Manual

Revisions to the Manual may be made from time to time, as the City deems appropriate. As revisions are made, copies of the revisions, as well as the original Manual, will be available to interested parties at the Office of Planning and Zoning at a reasonable cost.

D. Saving Clause

If an article, section, sub-section, clause, or phrase of this Manual is for any reason held unconstitutional or void, such decision shall not invalidate the remaining portions of the Manual.

WATER SYSTEM DESIGN

WATER SYSTEM DESIGN CHAPTER

1.0 GENERAL

1.1 Introduction

This chapter of the Brunswick Design Manual outlines the policies, minimum design criteria and design procedures for the preparation of feasibility reports and construction plans and specifications for City-maintained and on-site water system improvements. Developers and/or Design Engineers shall check with the City Office of Planning and Zoning to determine the availability of water at the site of a proposed subdivision. In the event a conflict exists between requirements, the more stringent applies.

1.1.1 City Policy

a. City-Maintained Facilities

The parts of the water supply system, which are considered as the property, and responsibility of the City of Brunswick are the water mains, appurtenances and that portion of the water services up to and including the curb stop or valve just inside the property line. The water supply and distribution system within the City's rights-of-way and easements for Brunswick is maintained by the City of Brunswick.

b. On-Site Facilities

The parts of the water services, which lie within private property, are the responsibility of the owner and are constructed and maintained by the Owner.

c. Requirements for Water Service

1. All properties will be connected to the water system of Brunswick.

a.) Each building shall be serviced by a separate water tap. Multiple dwelling units such as an apartment dwelling, duplex or residential unit with apartment(s) may be served by a single water tap.

b.) If an additional building is constructed on an existing lot which has a water tap, the new structure must be provided with an additional water tap.

c.) If a lot containing more than a single structure is subdivided to provide separate lots for each structure, the lot(s) without water tap(s) must provide these taps as a condition of subdivision.

d.) If a lot containing a single structure is subdivided, each structure erected upon the new subdivided area must procure a water tap prior to obtaining a building permit.

1.1.2 Definitions

a. Service Connections: Water mains connecting the distribution mains to individual homes, buildings, or facilities for both consumptive use and fire protection.

b. Distribution Mains: Water mains connecting the transmission mains to the service connections. The distribution mains provide area-wide fire protection. Generally, the distribution mains will be in a grid or branched configuration.

c. Transmission Mains: Large diameter mains connecting the treatment plant with the distribution mains.

d. Average Day Demand: Average day demand is the volume of water used in the year divided by 365.

e. Average Day Rate (Average Day): Average day rate is the average day demand volume divided by a one-day period, expressed in gallons per minute (gpm) or million gallons per day (MGD).

f. Maximum Day Demand: Maximum day demand is the largest volume of water used in one day during the year.

g. Maximum Day Rate (Max. Day): Maximum day rate is the water used during the maximum day divided by a one-day time period expressed in gpm or MGD.

h. Peak Hour Demand: Peak hour demand is the largest volume of water used in one hour.

i. Peak Hour Rate (Peak Hour): Peak hour rate is the peak hour demand volume divided by 60 minutes, expressed in gpm; or multiplied by 24 hours, expressed as MGD.

j. AWWA: American Water Works Association.

k. City: Mayor and Council of Brunswick.

l. Fire Flow: Rate of flow to allow for adequate suppression of a fire as suggested by the Insurance Service Office (ISO) or local fire officials.

2.0 DESIGN CRITERIA

2.1 General

For the Engineer's guidance, below are listed major elements constituting the design of a Water Main Utility Design project:

a. Pipe size and alignment

b. Profile, with all elevations

c. Property data (lot dimensions, all sides of affected properties, liber/folio number, owner)

d. Rights-of-way

e. Specifications and notes

f. Cost estimate

2.2 Demands

a. The sizing of major components of the City water supply system such as major transmission mains, water treatment plants, storage facilities, and booster pumping facilities, are the responsibility of the City and beyond the scope of this manual. The City may require developers to design these facilities as well as finance and construct them. Should this be the case, the City must be consulted for specific design criteria and ultimately review and approve the plans.

b. The design engineer who is responsible for the extensions of distribution mains shall follow the guidelines in this manual for the derivation of design flows. The calculation of water demands will usually require extension of the average daily rate for the facility, application of a peaking factor to derive the maximum daily rate, then addition of the fire flow requirement.

c. Generally, the design engineer will be selecting distribution mains of 12-inch diameter and smaller, and often will be required to provide the minimum size mains, which are listed later in this Chapter.

2.2.1 Residential Demands

Studies have shown that the quantity of average daily water use and peaking factor for residential areas are related to lot size. This is due to increases in persons per dwelling unit, per capita consumption, and greater lawn sprinkling as the lot sizes increase. The information in Appendix A shall be used to derive residential demands and peaking factors.

2.2.2 Commercial and Industrial Demands

The estimation of average daily water consumption and peaking factors for commercial demands are greatly dependent on the type of facility. With the exception of industries using process water, the fire demand generally is the major component of the design used to size distribution main extensions and service connections to buildings having sprinkler systems. The design engineer shall refer to the Frederick County plumbing code for derivation of building design flows if the number of fixture units is known. If the type of business is known, but a specific fixture count is not known, use Appendix D to estimate water demand. For undeveloped land, use Appendix A to derive Commercial and Industrial water demand according to zoning.

2.2.3 Fire Flow Rates

Residential: [1]	
Single Family	1,000 gpm at 25 psi residual
Cityhouses	1,500 gpm at 25 psi residual
Garden Type Apartments	2,000 gpm at 25 psi residual
High Rise Apartments	2,500 gpm at 25 psi residual
Commercial: [1]	
Regional Shopping Centers	3,000 gpm at 25 psi residual
Industrial: [1]	3,000 gpm at 25 psi residual
Institutions: [1]	
Hospitals	2,500 gpm at 25 psi residual
Schools	2,500 gpm at 25 psi residual
Office Building Complex: [1]	3,000 gpm at 25 psi residual

[1] Above fire flows to be used in the absence of site specific data from fire underwriters or construction plans, which would permit a determination of fire, flow requirements using insurance industry standards (Insurance Services Office -

ISO). Consideration will be given to reducing the requirement where proposed construction includes sprinkler system; refer to current ISO recommendations.

2.3 Hydraulic Computations

2.3.1 General

The hydraulic design of water mains shall be in accordance with the requirements of the American Water Works Association or Pipeline Design for Water and Wastewater, ASCE, 1975, and the additional guidelines and criteria in this Chapter.

2.3.2 Design Flows and Residual Pressures

a. Service connections, distribution mains and transmission mains shall be sized based on the following design flow rates and residual pressures:

Maintain a minimum of 25 psi at ground level anywhere in the system under all conditions.

or

Normal working pressure of 60 psi and not less than 35 psi residual pressure at the service connection during peak hourly rate.

The City Engineer and/or Public Works Director will determine which criteria are more critical.

b. In some locations, the main size will be determined by the flow rate required to refill a storage facility, which may be more critical than the above requirements. The City will identify this requirement, if applicable.

2.3.3 Flow Velocities

Although the flow velocities and direction may vary considerably in distribution mains, there are upper and lower velocity bounds that indicate to the design engineer that design weaknesses may exist. The following are useful guidelines:

a. Velocities greater than 7 fps at design flow

This condition may produce large friction losses and high potential for valve and joint damage due to water hammer.

b. Velocities less than 0.5 fps at design flow

This condition indicates that the main may be oversized. Future maintenance problems may result from siltation at valves and there may be water quality degradation.

2.3.4 Hazen-Williams "C" and Minor Losses

a. The total head loss at the point of discharge for design flows shall be the sum of both friction and minor losses. The elevation difference between the source and discharge point shall be algebraically added to the total head losses.

b. Head losses for new pipes shall be computed using the nomograph in Appendix C and the following coefficients:

Type	Pipe Diameter	Hazen-Williams "C"
Service Connections		
Copper	3/4 inch - 3 inch	130
DIP	3 inch	100
Distribution Mains		
DIP	4 inch - 8 inch	100
DIP	10 inch - 12 inch	110
DIP	16 inch - 24 inch	120
Transmission Mains		
DIP	16 inch - 20 inch	120
DIP	24 inch and larger	130

c. Minor losses due to fittings and valves shall be included as equivalent lengths of pipe as shown in Appendix E or as fractional losses in velocity head as described in Pipeline Design for Water and Wastewater, ASCE, 1975, or other hydraulics texts.

2.4 Distribution System Layout and Sizing

2.4.1 General

Extensions of distribution mains will normally be on a grid basis with interconnecting nodes at street intersections.

2.4.2 Residential Subdivision (New and Existing)

The water distribution system for residential areas where fire protection is to be provided shall meet the following criteria:

a. Minimum size of water mains shall be 8-inch.

b. All water mains shall be looped, except where capped for future extension to adjoining property. A fire hydrant shall be placed at the end of the main and may be relocated at the time the main is extended, if approved by the Office of Planning and Zoning.

c. A fire hydrant shall be placed within ten (10) feet of the terminus of all dead end mains.

2.4.3 Commercial and Industrial Areas

The water distribution mains for Commercial and Industrial areas where fire protection is to be provided shall meet the following criteria:

a. Minimum size shall be 8-inches.

b. All water mains shall be looped, except where capped for future extension to adjoining property. A fire hydrant shall be placed at the end of the main and may be relocated at the time the main is extended, if approved by the Office of Planning and Zoning.

c. A fire hydrant shall be placed within 100 feet of the terminus of all dead end mains.

d. Where design flow rates exceed 1500 gpm, hydraulic computations shall be provided.

2.5 Service Connections

2.5.1 General

House connections for water shall be built to the meter vaults near the property line for all lots within a proposed development. All meters shall be placed in an outside vault and shall be Neptune Pro-read with automatic read disc placed in the lid. All adjacent improved lots which are not a part of the proposed development, but which may be served by the water line, shall be shown on the contract drawings.

2.5.2 Location

On the plans, indicate service connections 15 feet from the property line on the high end of the lot or at a location desired by the homeowner if the lot is already developed. Water

meters in vaults shall be placed near the property line and shall not be constructed in the curb or sidewalk.

2.5.3 Sizing

a. Service connections must be no smaller than 3/4 inches, the normal size for a residential dwelling. Twin house connections (3/4 inches each) will not be permitted in group and semi-detached developments to serve two adjacent houses.

b. For other than a residential dwelling, determine the water supply demand pursuant to the criteria in Section 2.2. The velocity in the service connection must not exceed 8 fps.

2.5.4 Cover

Cover over service lines must be a minimum of 3 feet 6 inches or as required by the Frederick County Plumbing Code, whichever is greater.

2.5.5 Clearances

Water house services shall be placed 7 feet horizontally from sewer house connections and a minimum of 1 foot clear above the sewer house connection or as required by the Frederick County Plumbing Code.

2.5.6 Materials

Piping material must be Type 'K' copper for residential service lines and ductile iron or copper for larger sizes.

2.5.7 Cross Connections

No cross connections where contamination can enter the potable water supply are permitted. No cooling water or condensate may be returned to the potable water supply line. All interconnections shall be approved by the City and other appropriate reviewing authorities.

2.6 Appurtenances for Service Connections

2.6.1 Meters (Location)

Meters shall be located near the property line inside a City standard meter vault.

2.6.2 Meters (Sizing)

Meter types for Commercial, Industrial and Institutional applications shall be determined by the City or authorized agent. Meters shall be installed to record all water usage, including fire flow.

a. Valves

A valve or corporation cock shall be provided on the water main side of each meter installation.

b. Backflow Prevention Device

Reduced pressure backflow prevention devices shall be required on all services to commercial/industrial or individual facilities and shall be located immediately adjacent to the outlet side of the water meter, fully accessible. Refer to AWWA, *Cross Connection and Backflow Prevention* for additional design criteria.

2.6.3 Installation

Installation of all service connections and appurtenances shall be in accordance with latest AWWA standards or manufacturer's recommendations. Such requirement shall be noted in specifications and on contract drawings.

2.6.4 Booster Pumps

Booster Pumps may be permitted for individual domestic or fire flow service with the approval of the City. Their use, however, shall be discouraged and will only be considered on a case-by-case basis.

2.7 Distribution Mains

2.7.1 Description

Distribution mains are 12 inches and smaller in diameter. For larger mains, design engineer should consult with the City regarding special design criteria.

2.7.2 Location

a. In new subdivisions

Lay water mains 7 feet from the centerline of the road right-of-way, generally on the side of the road toward high ground (on opposite side of road from the sanitary sewer). Locate mains within the pavement area, wherever possible, no less than 5 feet from curb or proposed curb. Water mains shall not be located under curb or sidewalks, except where the water main crosses in a perpendicular fashion.

b. In existing developments with curbs

Generally, location must be the same as in new subdivisions. The location of other existing and proposed utilities must be fully considered.

c. In existing developments with pavement and no curbs

Generally, location must be the same as in new subdivisions. An alternative location with the approval of the City will involve locating the main 2 feet outside the edge of pavement on the opposite side of the road from the sanitary sewer, except that the main must not be laid under a future curb. The location of other existing and proposed utilities must be fully considered.

d. Where utilities are extended to accommodate development, they shall be extended across the full frontage of the property being serviced.

e. In parks and public rights-of-way, where location of a water main would require removal of trees, the design engineer shall obtain approval of the City for tree removal.

f. Distribution mains may be designed on a curved alignment to reduce the number of bends. Along curves, the water main may be deflected at each joint within the limits given in the Appendix.

g. All water utility easements outside of road right-of-ways shall be 20 feet minimum width. No other utilities will be allowed in the water easement without the City's written approval.

2.7.3 Size

a. Distribution Mains

Shall be 8-inch minimum size and shall be interconnected at all intersecting streets, with valves on all mains at the intersection. Where the required flow exceeds the capacity of an 8-inch main or of the existing system, larger mains will be required.

b. Distribution mains shall be sized to provide the required design flow rate and residual pressures as detailed herein.

c. Transmission Mains

Sizing shall be based on a computerized network analysis

performed by the design engineer or as provided by the City, if available.

2.7.4 Materials

a. All distribution and transmission mains and fittings shall be Ductile Iron, double cement lined (latest AWWA C-151) with standard mechanical joints or push-on joints.

b. At bridge crossings, 16-inch and smaller ductile iron pipe shall have fiberglass insulation with vapor jacket wrapped by a full metal jacket for all exposed piping.

c. Expansion joints, insulated couplings and rollers shall be provided as required.

2.7.5 Installation

Installation of all service connections and appurtenances shall be in accordance with latest AWWA standards or manufacturer's recommendations. Such requirement shall be noted in specifications and on contract drawings.

2.7.6 Cover Over Pipe

a. Normal cover over water mains shall be 4 feet except at crossing over other utilities, where a minimal cover of 3 feet or a maximum cover of 9 feet may be allowed.

b. In new subdivisions

Cover shall be measured from finished grade of road or as specified by the City. Roads shall be graded to subgrade before water mains are laid.

c. In existing or ungraded roads

Established grades of roads shall be obtained from the City and are generally the proposed future finished grade. If such grades are not available, the design engineer shall submit proposed grades for approval by the City. If established grade is at or below existing surface, cover shall be measured from established grade. If established grade is above existing surface, cover shall be measured from existing surface. In no case, however, shall the cover deviate from the minimum or maximum cover indicated in 2.7.6.

2.7.7 Clearances

a. Clearances shall be measured between outside of pipes.

b. Crossing Sanitary Sewer

Water main shall have minimum clearance of 18 inches above sewer. This vertical separation shall be maintained horizontally for a distance of 10 feet or as required by the Maryland Department of the Environment.

c. Parallel to Sanitary Sewer

A horizontal distance of at least 10 feet shall separate water main and sewers or as required by the Maryland Department of the Environment.

d. Crossing Other Utilities

Water mains shall have minimum clearance of eighteen inches where crossing utilities.

EXCEPTIONS: When specified clearance is not physically possible between sewer and water in a new subdivision or in locations where sewer is built along roads having existing water mains, the sewers shall be designed according to Sewer Design Standards of Brunswick. If sewers already exist in a road, and water main cannot be built to specified clearances, ductile iron pipe with mechanical joints or other approved safety joints shall be used for the water mains. These installations shall be pressure tested to assure water tightness before backfilling. The City shall be consulted to discuss the use of concrete encasement of the sewer and/or water main. The Developer or Engineer shall propose options to the City for approval to ensure all possible measures are considered and implemented to avoid possible contamination of the water supply.

2.7.8 Structural Considerations

a. Buttresses and Anchors

Buttresses and anchors shall be required at all fittings which achieve a change in pipeline direction, such as tees, fire hydrants, bends and dead ends, thrust restraint is necessary. Buttresses and/or anchorage blocks are the two means of achieving thrust restraint. The design engineer shall decide what is appropriate for each particular situation based on an analysis of such factors as soil conditions, clearance requirements, constructability, future expansion and cost. Buttresses and Anchorage blocks are concrete placed against undisturbed soil designed for restraint of thrust forces in pressurized piping systems. The City reserves the right to require a soils analysis.

b. Restrained Joints

If the soils at the project site are unusually poor, or other factors such as cost, space limitations, or future construction so indicate, restrained pipe joints shall be designed. The joint restraint may be either harnesses or mechanical joints with retainer glands for mains up to 16-inch diameter. Restrained joint types for larger mains shall be approved by the City prior to proceeding with design. The design shall account for test pressures, soil frictional resistance and effect of groundwater as a minimum. The City reserves the right to require a soils analysis.

c. Jacking and Tunneling

Where mains are being designed to cross railroads, state highways, or other roads, on which service cannot be interrupted, the water main shall be installed in a sleeve, tunneled or jacked under the road. The sleeve size and material and the method of tunneling or jacking shall be approved by the owner of the road or the railroad being crossed.

The sleeve diameter shall be sufficient to permit the proper positioning of the water main within the sleeve. Water mains installed in sleeves shall have restrained joints throughout the length of the sleeve. The annular void between the main and the sleeve shall be completely filled with grout.

Water mains installed in sleeves shall be equipped with sufficient valves to shut-off all flow through the sleeved section. In the case of dead end main, one valve upstream will be sufficient; in other cases, a valve at each end is required.

d. Design Loads and Pipe Design

In cases where deemed necessary by the City, the design engineer shall submit all calculations necessary to support the selection of the type and class of pipe indicated on the Contract Drawings.

The calculations may account for the following:

Vehicle or railroad loads (H-20, E-80, etc.);
Pipe loading factors (dead, live, impact);
Internal pressure (static, dynamic, surge);
Installation trench configuration.

e. Corrosion Protection

If soil tests or inspection of existing utilities in the project area reveals evidence of, or potential for, corrosion, the City shall be notified of the condition. Should the City deem it necessary, the design engineer shall design suitable galvanic

and/or cathodic corrosion protection measures using AWWA Controlling Corrosion Within Water Systems, 1978. The City reserves the right to require a soils analysis for corrositivity.

f. Deflection of Pipe

The maximum deflection allowed shall be as shown in Appendix B of this Manual.

2.8 Appurtenances for Service Mains

2.8.1 Valves

a. Size and Type

Mains 4-inches to 16-inches shall have valves of the same size as the main. Valves shall be resilient seat gate valves with non-rising stem. All valves 16-inches and larger shall have bevel gears and an enclosed gear case.

b. Location

Valves shall be installed on the loop or network at such places as to isolate the branch sections as may be necessary with a maximum spacing of 1500 feet. They shall be installed on all fire hydrant leads as close to the water main as is feasible. A valve shall be placed on all branch lines, regardless of size, near the main. Valves at intersections shall be placed on projection of road right-of-way lines. In no case shall the valve be placed in the sidewalk or less than ten feet (10') from another valve.

2.8.2 Tapping Sleeves and Valves

Where Used: Tapping sleeves and valves on ductile iron mains to serve as line valves shall be used for all connections 6-inches and larger to any existing main 12-inches or larger where more than 10 domestic services would be shut off during installation of a standard tee. The main being tapped may be the same size as the proposed main or tapping valve, but the tapping cutter shall be 1/4-inches or more undersized.

2.8.3 Fire Hydrants

a. Size and Type

Hydrant leads shall be a minimum of 6-inches. The engineer shall submit to the City a scale map 1 inch = 200 feet showing area streets, water mains and proposed

location of fire hydrants for the City's use and for transmittal to the Fire Department. Fire hydrants shall be Mueller, Model A-423 or Kennedy Model K81. Each hydrant shall have one (1) 4½ inch diameter pump nozzle and two (2) 2½ inch hose nozzles, nozzle gaskets, 5¼ inch valve, 1½ inch pentagonal operating nut, open left. Both the hose nozzles and pumper nozzle shall have National Standard Thread. Hydrants shall be designed for 4½ foot bury and 6 inch mechanical joint inlet.

b. Location

Hydrants shall be located in a pattern approved by the City Engineer or his duly authorized representative and shall be located so as to provide vehicular clearance from the street. Hydrants not at intersections shall be located in relation to property lines in order to avoid interference with future driveways.

c. Spacing

Hydrant spacing in residential areas composed of detached or semi-detached one- and two-family dwellings shall be at each street intersection and at 500-foot maximum intervals between intersections. Hydrant spacing in other residential areas and all other uses of property shall be at each street intersection and at 300-foot maximum intervals between street intersections.

2.8.4 Air and Vacuum Release Valves

a. The proper ventilation of distribution and transmission mains is often overlooked by design engineers. Trapped air pockets can significantly reduce the capacity of the mains as well as cause increased pumping heads and corresponding higher pumping costs. The following guidelines shall be used to locate air and vacuum release valves:

Peaks in profiles
Abrupt increase in downward slope
Abrupt decrease in upward slope
Long ascents - 1500 ft to 3000 ft intervals
Long descents - 1500 ft to 3000 ft intervals
Long horizontals - 1500 ft to 3000 ft intervals
Pumps - on the discharge side of pump having suction as close to the check valve as possible

b. In general, fire hydrants shall be placed at all high points along the main and at the terminus of dead end mains.

2.8.5 Valve Vaults

a. Mains 12-Inches and Smaller

For valves and for tapping sleeves and valves, use the Frederick County Standard Roadway Valve Box.

b. Mains Larger than 12-Inches

For valves, except butterfly-type, use reinforced concrete vaults as approved by the City. For tapping tees and valves, use concrete vaults as approved by the City.

2.9 Testing and Disinfection

The contract documents shall provide for hydrostatic testing of newly laid mains as described in the Frederick County Standard Specifications. Hydrostatic tests shall be performed for pressure retention and leakage. Disinfection shall be in accordance with AWWA C-651.

2.10 Abandonment Procedures

Abandoned service connections shall be cut and plugged at the service main, and the meters removed and salvaged if their condition permits reuse. Distribution mains that are to be abandoned shall be plugged at the point of abandonment and on each side of any existing valves, and the valves and hydrants removed and salvaged if their reuse appears practicable. Any necessary buttresses or anchorage required shall be designed in accordance with Frederick County Standard Details.

2.11 Water Pumping and Treatment

A detailed presentation of design criteria for pumping and treatment facilities is beyond the scope of this manual. The City will specify the exact requirements to be met by the design of these facilities.

2.12 Water Storage

2.12.1 General

A water system must be able to meet the peak hour demand during the maximum demand day to be effective. However, it is not economically feasible for domestic water systems to provide sufficient supply capacity to meet these peak demands. Therefore, to stabilize pressure and also to provide the necessary reserve capacity to meet peak demand period, it is the usual practice to provide storage reservoirs as an integral part of any distribution system.

During periods of peak demand, such as fire conditions, the required volumes of water that cannot be provided from the system's supply source are taken from the system's distribution storage. During periods of low demand, the excess water from the supply source returns to storage until the facilities are again full, completing the cycle.

The criteria used to determine the proper size of storage facilities can best be understood in terms of the functions which storage facilities are intended to perform. These functions may be summarized as follows:

a. To provide an equalizing reserve.

b. To provide a fire reserve.

c. To provide an emergency reserve.

2.12.2 Equalizing Storage

The equalizing reserve is the quantity of water needed to even out or "equalize" the system demands during a day's operation. By providing this reserve, the storage facilities make it possible to operate the treatment facilities and pumping stations at a relatively uniform rate. When the system demand is higher than the supply rate, water is withdrawn from the storage facilities. Conversely, when the system demand is below the supply rate, water is returned to storage to ensure that an adequate quantity is available for the next period of high demand. In general, systems which have an equalizing reserve equal to 20% of their maximum daily demand operate satisfactorily.

2.12.3 Fire Reserve

The size of the fire reserve is indirectly set by the Insurance Services Office (ISO), formerly known as the National Board of Fire Underwriters. This agency sets standards for the amount of fire flow that should be available at various points in a community.

2.12.4 Emergency Reserve

The emergency reserve is included as a safeguard against disruptions in the supply source, ruptured water mains, well-pump interruptions, or other circumstances which would exert an additional demand on the storage facilities. Normally, the quantity allotted for emergencies is 25% of the total effective storage volume.

2.13 Repaving of Roads

2.13.1 General

a. All City construction contract specifications shall include a "patch-pave" requirement as follows:

Properly compacted borrow aggregate backfill shall be placed and compacted from 3 inches below the pipe to the bituminous pavement subgrade. The pavement replacement shall consist of a base course of asphaltic concrete of at least a thickness equivalent to the original pavement section, the original wearing course cut back two-feet on all edges of the excavation and a new asphaltic concrete wearing course of at least a thickness equivalent to the original wearing course. Other road pavement sections will receive similar treatment. In all cases, however, the base course shall be a minimum of 4-inches, and the wearing course shall be a minimum of 2-inches.

b. Patch-paving as outlined above is to be accomplished whether the roadway is to be re-paved or not.

c. House connection installations will require the same specifications for patch-paving.

d. All paving/repaving work will be accomplished in accordance with the City Road Specifications or Design Manual. A "road cut" permit must be obtained from the City when excavating within an existing City maintained roadway.

e. Pavement patch in County or State roads shall comply with the requirements of the jurisdiction.

2.13.2 Timing of Patch-paving and/or Repaving

a. Specifications will provide that patch-paving shall be accomplished immediately after backfilling and achieving specified compaction for connection and small extension contracts; and at no greater than seven (7) calendar day intervals for larger projects. Temporary "cold patch" shall be required for patches not immediately patch-paved. The City must be consulted if immediate patch-paving cannot be accomplished. Cold patching must be maintained by the Developer to the City's satisfaction. The placement of steel plates over trenching may be approved by the City on a case-by-case basis.

b. Repaving shall be specified to be accomplished in one continuous effort to best assure economy and consistency of quality work.

2.13.3 Traffic Control

All water utility construction projects shall have an approved traffic control plan, using requirements of the *Manual on Uniform Traffic Control Devices*.

3.0 CONTRACT DRAWINGS AND DOCUMENTS

3.1 Reports

For mains larger than 12-inches, three copies of a preliminary report shall be submitted to the City. The report shall include a sketch of the preliminary layout and a summary of the design data.

3.2 Design Computations

a. Design engineers shall submit three copies of design data and calculations for all water projects. The computations shall be in accordance with methods presented in this manual.

b. The design data and computations shall include: average and peak demands, fire demand, and future requirements.

c. Design computations for all special structures shall be submitted. Where information pertinent to design, such as borings, has been collected, this information shall be submitted to the City. The locations of borings shall be shown on the plan sheets, and the boring logs shall be included in the Contract Documents. See Appendix F for Geo-Technical Requirements. In addition, the City reserves the right to require borings and geotechnical information.

3.3 Specifications

Contract specifications shall utilize the City of Brunswick Specifications or, in the absence of City Specifications, the Frederick County Specifications will apply.

3.4 Contract Drawings

3.4.1 Preparation

Water main contract drawings shall be prepared on drawings separate from drawings detailing the road design. Separate drawings shall be used for each street.

3.4.2 Plan

a. Scale: 1 inch = 50 feet.

b. Method of Indicating Location

Generally, water mains and structures shall be located in Plan by dimensions from property markers or other well defined physical features. However, in areas where physical features are not available, coordinates of structures and bearings of water mains based on the Maryland Coordinate System NAD 83/91 shall be used.

c. Fittings

A list of all valves and fittings required shall be shown on each drawing.

d. Contract drawings shall include the property line surveys and all lot dimensions of the land bordering water extensions and shall indicate the names of the present owners of such property with the recording reference number of the deed, lot numbers, house numbers, subdivision names and block numbers, as well as existing rights-of-way or easements. When rights-of-way must be obtained, a right-of-way drawing for each property shall be provided, accompanied by a written description of each right-of-way.

3.4.4 Profile

Profiles shall be shown for all water mains. Profile shall be on same sheet as the Plan.

a. Scale

Scale of all profiles shall be 1 inch = 50 feet horizontal; 1 inch = 5 feet vertical. Water main profiles on straight streets shall be shown to correct scale. On curved streets, horizontal distances between structures shall be plotted using length of street centerline between radial projections to structures. The true length between structures shall be shown by figures.

b. Road Grades

Approved established grades shall be obtained from the City. When such grades are not available, they shall be established by the design engineer and submitted to the City for approval.

The established grade (noted as top of curb or centerline) shall be shown. Where water main is located in present or proposed pavement or shoulders, the existing centerline grade of road shall be shown. Where water main is outside pavement or shoulders for a length greater than 50 feet, existing ground over water main shall be shown and labeled.

c. Water Main on Fill

Where water main is to be constructed on fill, a profile of the undisturbed earth (at water main location) shall be shown.

3.4.5 Other Utilities

Other existing and proposed utilities shall be shown accurately and clearly in Plan and Profile.

3.4.6 Location and Design Information

A Location Plan showing well known streets at a scale of 1 inch = 200 feet shall appear on the first drawing of each set of Contract Drawings. A schematic layout of the proposed extensions to the water system and adjacent existing lines shall be shown. The location of existing valves which must be shut off when the new line is connected must be shown. Existing and proposed fire hydrants shall also be shown.

3.4.7 Special Details

Structures or details not included in the Standard Details shall be detailed clearly on the Contract Drawings, preferably where the detail is located in Plan.

3.4.8 One (1) copy of the As-Built drawings on mylar plan sheets with the statement and Engineer's signature, as shown in the Appendix, shall be submitted to the Office of Planning and Zoning within thirty (30) days of completion and acceptance of the work by the City and on computer or GIS diskette in a format approved by the Office of Planning and Zoning.

3.5 Estimate of Project Costs

The engineer shall submit an estimate of project costs for each contract, including contingent items and a 15% contingency based on the total cost of the project.

APPENDIX A

BASIS FOR RESIDENTIAL WATER DEMAND PROJECTIONS
FOR UNDEVELOPED OR PARTIALLY DEVELOPED AREAS

Projected Population Zoning Factor	Projected Dwelling Units Factor	Projected Demand Avg Per Acre Based on per Acre GPD/Acre	Maximum Day Peaking per Acre	Maximum Day Demand 200 GPD/dwelling
AG (Agricultural) 400	2.6	1	200	2.0
RS (Residential Suburban 1600 Low Density)	10.4	4	800	2.0
R-1 (Low Density Residential) 2800	18.2	7	1400	2.0
R-2 (Medium Density Residential) 3600	23.4	9	1800	2.0

Zoning	Maximum Day Demand GPD/Acre	Projected Flow per Acre	Avg Day Peaking Factor
COMMERCIAL:			
B-1, B-2, B-3, GC, HS	700	*500	1.4
LIGHT INDUSTRIAL :			
I-1, OR	650	*500	1.3
HEAVY INDUSTRIAL:			
I-2	1100	*1000	1.1

*Use Appendix D when the specific type of development is known. Use Frederick County Plumbing
Code when a specific fixture count is known.

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STORM DRAINAGE DESIGN CHAPTER

1.0 INTRODUCTION

1.1 Purpose of Storm Drainage Design Chapter

This chapter is intended to provide acceptable criteria, methods, and a framework within which the goals of storm drainage systems may be achieved in effective and efficient ways. In the event a conflict exists between requirements, the more stringent applies.

1.2 Laws, Ordinances and Policies

It shall be the responsibility of the developer to be aware of all applicable laws, ordinances and policies associated with the storm water field for projects under design and construction. This design manual is not intended to supersede the laws and regulations of the Natural Resources Conservation Service, the Maryland Department of the Environment, or the State Highway Administration for storm drainage within the State Highway Administration right-of-way.

1.3 Easements, Ownership and Maintenance

It is the City's policy to require that all storm drainage facilities, whether natural or improved, surface or subsurface, including storm water management facilities, to be within an easement, right-of-way or City owned lands.

a. Subsurface drainage facilities which convey drainage flow from a public right-of-way shall be enclosed within a drainage easement or City owned lands.

b. Surface drainage facilities which convey drainage flow from a public right-of-way shall be enclosed within a drainage easement or City owned lands.

c. Surface drainage facilities conveying storm water from upstream lots comprising a total area of less than one acre or one lot will not be required to provide a drainage easement, but the construction plans or the site development plans for the development shall show a drainage swale or underground pipe system which will accommodate the flow.

d. For natural drainage systems, the 100-year floodplain shall be enclosed by a "100-year floodplain and drainage easement" or City owned

lands, which shall be defined by bearings, distances and coordinate values; be tied to property lines; and show the floodplain elevations at all bearing changes and at intervals not exceeding 200 feet between bearing changes.

e. Storm water management practices which are to be maintained by the City shall be enclosed within a drainage easement or City owned lands, which shall include a 20' minimum access surrounding the facility.

f. For improved channels, the 100-year floodplain shall be enclosed by a 100-year floodplain and drainage easement extending beyond the floodplain on both sides of the channel for purposes of access and maintenance.

1. For channels having a top width of 30 feet or less, the easement or right-of-way on one side of the channel shall extend beyond the 100-year floodplain to a line a minimum distance of 10 feet outside of the floodplain. On the opposite side of the channel, the easement or right-of-way shall extend beyond the 100-year floodplain to a line a minimum distance of 20 feet outside of the floodplain. The wider easement or right-of-way shall be located continuously on the same side of the channel between intersecting public roads, but may switch sides of the channel on the opposite side of a public road.

2. For channels having a top width in excess of 30 feet, the wider easement or right-of-way criteria shall apply to both sides of the channel.

g. Discharge and Drainage Easements: Discharge easements for the major drainage system will normally not be required from downstream property owners unless the point of discharge has been significantly altered in location or the size of the drainage basin has been significantly increased in area. Drainage easements for the major drainage system will normally not be required from upstream property owners unless one or more of the following conditions occurs:

1. The point at which the flow crosses the property lines is significantly altered in location. The developer will also be

   required to construct all facilities to direct storm water runoff to the new point of entry.

2. There is existing development upstream with an closed-conduit channel system and the hydraulic grade line or energy grade line at the next upstream structure is raised above its original or recomputed value.

3. There is existing development upstream with an open-channel system and the hydraulic grade line in the open channel at the property line is raised above its original or recomputed value.

4. There is undeveloped land upstream and a proposed project improvement, other than a bridge or culvert, would raise the hydraulic grade line at the property line above the 100-year floodplain based on the existing natural upstream channel and the ultimate runoff of the fully developed watershed. A flowage easement will be required only if the backwater or headwater at the property line exceeds the previously defined 100-year floodplain by one foot for a bridge or for a culvert. In no case shall an increase be allowed at the property line, with or without a flowage easement, if it causes flooding or increased flooding of existing structures.

h. All existing or proposed surface drainage facilities such as swales, streams, storm water management facilities, unpaved and paved channels, etc., located within privately owned easements will be the legal responsibility of the property owner for operation and maintenance. The property owner(s) will be required to enter into an agreement with the City to allow the City to inspect and enforce proper maintenance procedures.

i. Surface drainage from an area comprising one acre or more shall be intercepted at the point where the drainage area is equal to or less than one acre and conveyed to a suitable point of outfall via an underground storm drain pipe properly designed to accommodate the drainage expected from ultimate development. Recognizing that it may not be possible or feasible, due to topography or underground impediments, to convey storm drainage the full length to an acceptable stream or other outfall via an underground pipe, the terminal length of the system may consist of an open swale or ditch properly lined to prevent erosion. Should the terminal end of the conveyance system be required to be an open swale or ditch, as determined by the City, the length of the open swale or ditch shall be the minimum needed to overcome topographic, underground impediments or other physical constraints.

2.0 SUBMITTALS

2.1 General Submission Requirements

2.1.1 Introduction

The Office of Planning and Zoning administers the review and approval process for all subdivision and land development projects and Capital Improvement Projects. Current information concerning applications, review fees, numbers of copies, etc., should be obtained from the City Office of Planning and Zoning.

In many cases, storm drainage facilities will be presented on roadway, site development, and other plans which include other improvements. If this occurs, the requirements for the storm drainage facilities shall be coordinated with the requirements for other improvements.

2.1.2 Design Computations

Appropriate hydrologic, hydraulic, geometric, structural, and other design computations, together with the environmental inventory and assessment, shall accompany all submissions for storm drainage improvements. If an appropriate form or table is not presented in the Design Manual, a suitable engineering style of computation shall be followed.

Complete sets of hydrologic and hydraulic design computations shall be included with all submission, review and record copies of plans involving storm drainage facilities. The materials may be included at the original size of the various computation tables and forms or they may be combined in sequence and reproduced on 24 inch x 36 inch sheets to match the size of the plan sheets. These items need not be included in sets of plans for bidding or construction purposes. In addition to those bound into the plans, two (2) copies or more, if required, of all storm drainage design computations shall be submitted in separate binders which will fit in a standard letter or legal sized file.

2.1.3 Specifications

All storm drainage construction shall meet or exceed the following specifications as appropriate:

a. State Highway Administration Specifications for Materials, Highway, Bridges, and Incidental Structures, latest edition for all work within the State Highway Administration's right-of-way.

b. 1994 Maryland Standards and Specification for Soil Erosion and Sediment Control or most current edition for all work within the City Boundaries.

c. Frederick County Plumbing Code, latest edition for work on private property.

d. Brunswick Standard Details and Specifications for Construction, latest edition for all work within the City Boundaries and outside of County, State or Federal land.

Specifications for items not covered in these specifications shall be submitted to the City for review and approval. Whenever a conflict exists between the standards mentioned herein, the most stringent requirement(s) will apply.

2.1.4 Quantities and Cost Estimates

In conjunction with other required public improvements, design engineers shall submit a tabulated estimate of all quantities and costs, including contingent items, for all storm drainage facilities, soil erosion and sediment control measures, and storm water management facilities. The Office of Planning and Zoning should be consulted for information relating to the latest format for both development and Capital Improvement Projects.

2.1.5 Easement Plats and Transmittal Sheets

Where storm drainage facilities will occur in areas outside of public roads and highways or easements to be shown on the project final subdivision plat, supplementary easement plats will be required.

2.2 Specific Plan Requirements

2.2.1 Introduction

The purpose of this section is to indicate the specific requirements for storm drainage facilities, soil erosion and sediment control measures, and storm water management facilities as shown in the various plan submissions. The City's Subdivision Regulations provide requirements for plan submissions which shall include storm drainage facilities, easements, if applicable.

2.2.2 Drainage Area Map

Off-site drainage area maps shall be prepared from the largest practical and available scale topographic maps. On-site drainage area maps shall be prepared at the scale of project preliminary or site development plan. Preliminary drainage area maps shall be revised to reflect final design conditions if they are to be utilized for the final drainage area map.

The entire area under consideration shall be subdivided into areas tributary to entry or design point. Each tributary area shall be delineated by bold, dashed lines along its ridges. Sufficient flow arrows shall be shown to clearly indicate high points, direction of surface runoff, direction of gutter or channel flow and points of concentration. Final drainage area maps shall show all paths of drainage at street intersections, gutters and side road ditches.

2.2.3 Construction Plans

a. Construction plans involving storm drainage shall include, at a minimum, the following:

Grading Plans

Road Plans

Site Development Plans

Soil Erosion and Sediment Control Plans

Storm Water Management Plans

Storm Drainage Profiles

Detail Sheets

Structure and Pipe Schedule

Final Drainage Area Maps

Storm Drainage Plan-Profiles

1. Grading Plans: Separate grading plans may be required by the Office of Planning and Zoning if a road or site development plan is insufficient or too complex to portray area grading. These plans are normally prepared at the same scale as the preliminary or site development plan. They should show existing and proposed

grades, contours, temporary or permanent drainage, existing features and be coordinated with the Soil Erosion and Sediment Control Plan.

2. Road Plans: These plans shall show the location and geometrics of the storm drainage system and its horizontal relationships with property lines, easements, public roads, and other existing and proposed improvements. This plan shall also show the drainage system identification, size, structure schedule and flow directions.

3. Site Development Plans: Site development plan requirements are delineated by the subdivision and land development regulations. Insofar as storm drainage is concerned, they fulfill essentially the same function as roadway plans. Additionally, they are often utilized to indicate the 100-year floodplains, grading, soil erosion and sediment control, if separate plans are not to be prepared. Floodplains shall be determined.

4. Soil Erosion and Sediment Control Plans: These plans are usually prepared on a reproducible copy of the preliminary grading or site development plan and hence have the same scale as these plans. They shall show the location and geometrics of the erosion and sediment control measures and the horizontal relationships of them with property lines, easements, public roads, and other existing and proposed improvements. This plan should also show necessary seeding and other specifications, construction sequences, details, watersheds being served by sediment basins, and certifications. The Natural Resources Conservation Service should be consulted for the latest requirements.

5. Storm Water Management Plans: These plans are utilized if other plans are not appropriate to show the storm water management facilities. A reproducible copy of the preliminary grading or site development plan may often be utilized for this plan. This plan serves the function of all plans for the horizontal location of the improvements. In addition, this plan shall also show necessary specifications, special details or structures, watersheds being served, maintenance responsibilities, and certifications.

6. Storm Drainage Profiles: Storm drainage profiles are utilized in conjunction with some type of plan which shows the

horizontal aspects of the storm drainage facility. Storm drain profiles shall show the existing and proposed grade of closed conduits, the conduit size, type, class, length, slope, upstream and downstream invert elevations, structure invert development and designations, design discharge, full-flow velocity and part-full velocity, if the last was computed. In addition, the profiles shall state and show graphically the locations of the hydraulic grade line as specified. For open channels essentially the same information shall be shown except that both the water surface and energy grade line profiles shall be stated and shown graphically. Approximately 400 feet upstream and downstream of the water course shall be shown.

7. Detail Sheets: If other types of plans or profiles are insufficient, detail sheets may be necessary. They contain architectural, structural, and other elements of any special details. They are prepared to an architectural scale, usually 3/8 inch = 1 foot for simple details and as large as 3 inches = 1 foot for highly complicated details. They shall clearly present all information necessary for the fabrication or construction of the item. For significant structures subsurface exploration data, design standards, loadings, foundation pressures and design stresses shall be given. Major material categories or specifications shall also be given.

8. Final Drainage Area Maps: These represent a refinement of the preliminary drainage area maps.

9. Storm Drainage Plan-Profiles: This special type of plan is utilized if the drainage facility is the major improvement. Scales will be similar to those for road plan-profiles. These plans shall contain essentially the same information contained in the previously described plan types and the separate storm drainage profiles.

10. Structure Schedule and Pipe Schedule.

11. Three (3) copies of the final plans shall be submitted to the Office of Planning and Zoning for use by the City in updating the City's system maps.

12. One (1) copy of the As-Built drawings on mylar plan sheets with the statement and Engineer’s signature, as shown in the Appendix, shall be submitted to the Office of Planning and Zoning

within thirty (30) days of completion and acceptance of the work by the City and on computer or GIS diskette in a format approved by the Office of Planning and Zoning.

2.2.4 Final 100-Year Floodplain Determination

In addition to the necessary computations, the following shall be submitted:

a. Channel and floodplain cross-sections plotted on full cross section paper (1 inch = 20 feet or 50 feet horizontal, and 1 inch = 5 feet vertical) or presented as computer plotter output. Indicate Manning n factor for each subsection of cross section.

b. Channel profile (1 inch = 100 feet horizontal and 1 inch = 10 feet vertical, or 1 inch = 50 feet horizontal and 1 inch = 5 feet vertical) plotted on full cross section paper or computer plotter output with the channel meander used as the horizontal length and showing the tops of channel banks, water surface, energy grade line, and distribution of flow and average velocities for overbanks and channel, if available.

2.2.5 Final Subdivision Plat

For storm drainage, the plat shall show drainage easements, 100-year floodplain limits and elevations, maintenance responsibilities and dedication statements.

2.2.6 Capital Improvement Projects

Capital Improvement Projects shall meet the same general criteria as the developer projects and shall meet the site specific project scope of services.

2.3 Review and Approval

Storm drainage submissions will be reviewed by the following agencies for compliance with the given requirements:

a. City Office of Planning and Zoning for compliance with the Subdivision and Land Development Regulations and for compliance with the following:

1. Subdivision and Land Development Regulations

2. Design Manual

3. Grading Permit

4. Storm water management inspection schedule, reports and requirements during construction

5. Storm water management maintenance and maintenance agreement

b. Other City or Frederick County agencies for compliance with the subdivision and land development regulations.

c. Natural Resources Conservation Service and Maryland Department of the Environment, as appropriate, for compliance with 1994, Maryland Standard Specifications for Soil Erosion and Sediment Control and NRCS criteria for the design of dams and ponds for storm water management.

d. Department of Transportation, State Highway Administration for compliance with its design practices, criteria and specifications for construction within its rights-of-way for an access permit.

e. Maryland Department of the Environment for issuance of a permit involving construction in a major floodplain or a major dam and reservoir where drainage area is 200 acres or greater for Class I and Class II waterways and 100 acres for Class III and Class IV waterways.

f. U.S. Department of Housing and Urban Development, Federal Insurance Administration for compliance with its criteria and regulations for floodplain delineation for Federal Flood Insurance.

g. U.S. Army Corps of Engineers for permit.

3.0 STORM DRAIN DESIGN STANDARDS

3.1 Criteria and Procedures

The criteria and procedures for design shall be consistent with approved environmental practices and existing laws and regulations which are concerned with storm water runoff. They are also intended to be compatible with the Natural Resources Conservation Service, Maryland Department of the Environment, and the requirements of other State and County agencies as they pertain to the City of Brunswick.

3.2 Topographic and Land Use Maps

Topographic maps shall be obtained from the Office of Planning and Zoning, if available. If additional or supplemental topography or planimetric mapping is needed, the Developer shall be responsible to secure the information. Zoning and approved land use maps are available from the Office of Planning and Zoning.

3.3 Drainage Problems not Covered Herein

When a specific drainage problem is encountered which is not covered in the Section, it will be the responsibility of the Engineer to furnish the Office of Planning and Zoning with calculations and other data supporting his design.

4.0 HYDROLOGY

4.1 Rational Method

The rational method may be used for homogeneous drainage basins of 100 acres or less for closed storm drain systems. For drainage basins greater than 100 acres, but less than 500 acres, it may be used for determination of peak runoff only. Ultimate conditions shall be determined based on the City of Brunswick Master Plan. Existing and pre-developed conditions shall be determined based on 1" = 200' scale or large topography and field recommendations. The rational method may not be used for storm water management design, culvert or bridge crossings. With the rational method, the peak discharge at any point may be determined by the formula: Q = CIA

In this formula:

Q = the peak discharge in cfs
C = the runoff coefficient
I = the average rainfall intensity in inches per hour
A = the drainage area in acres

For clarity: in/hr x acres = 1.008 cu ft/sec

4.2 Hydrograph Methods

The size of the drainage area shall be limited to 500 acres maximum and shall be homogenous with respect to the time of concentration and land use. The latest version of Natural Resources Conservation Service (NRCS) TR-55 "Urban hydrology for Small Watersheds" may be used for small watersheds. The latest version of NRCS TR-20 "Computer Program for Project Formulation-Hydrology" may be used for areas greater than 500 acres.

4.3 Rainfall Intensity (I)

Use the NRCS Type II rainfall distribution for a 24-hour storm and antecedent moisture condition II.

4.4 Time of Concentration (T_c)

4.4.1 How Determined: The time of concentration consists of the sum of the inlet time and the time of flow in the system from the most hydraulically distant point in the drainage area to the point under consideration. Inlet time includes time for establishment of flow and time in swales, ditches, gutters, etc. An acceptable average value of the inlet time as a function of percentage impervious area may be obtained from the following relationship: $T_i = 15.0 - PI/8$ in which T_i is the inlet time in minutes and PI is the percent impervious area within the inlet area under investigation.

4.4.2 By Zoning Classification

a. Minimum Inlet Time: Shall be 5 minutes regardless of zoning classifications.

b. Maximum Inlet Time: For zoning classifications with an allowable percent impervious area greater than 50%, the maximum allowable inlet time shall be 7 minutes.

4.5 Runoff Coefficients (C)

The runoff coefficient is a factor, which relates the runoff rate to the rainfall intensity. This coefficient is dimensionless and takes into account the percent impervious, soil type, and slope of contributing drainage area.

Average values of runoff coefficients are shown in Table 2 for various land uses. A composite "C" value for the drainage area under consideration is computed in an area-weighted average of the individual runoff coefficient of the various sub-areas of the watershed.

4.6 Special Considerations

4.6.1 Partial Area Contribution

In some watersheds, particularly if there are large amounts of impervious areas near the downstream portions of the basin, the peak rate of runoff may be realized when only these areas are contributing. Because the design intensity will be based on their shorter time of concentration, rather than the longer time of concentration

for the entire watershed, the discharge may be greater than when the entire watershed contributes at a reduced intensity and runoff coefficient.

4.6.2 Apparent Reduction in Peak Discharge

In many watersheds, particularly where the mainstream channel is in a natural condition and there are not significant tributaries, the intensity values associated with time of concentration based on the travel time in the mainstream will decrease faster than the total area of the watershed increases. This results in a decrease in the product of I times A and, hence, the peak runoff shall not be decreased, but the greatest upstream value of peak runoff shall be used until a point is reached for which the peak runoff rate again increases.

4.7 Watershed Modeling

4.7.1 Soil Conservation Service TR-20

The NRCS's Technical Release No. 20 "Computer Program for Project Formulation-Hydrology" is a valid approach to hydrologic modeling of watersheds and should be considered when any of the following conditions exist:

a. Watersheds are larger than 500 acres.

b. There are many sub-area with different runoff characteristics.

c. Reservoirs and dams are either existing or proposed.

d. Historical storm events need to be analyzed.

e. A complete flood hydrograph is desired.

4.7.2 NRCS's Tabular Method

Smaller watersheds may be analyzed using the NRCS's Tabular Method as described in Technical Release No. 55, "Urban Hydrology for Small Watersheds."

4.7.3 Other Models: Other hydrologic computer programs may be used with prior approval of the Office of Planning and Zoning. A user's manual and complete input data and printout must be submitted for each project.

5.0 HYDRAULICS

5.1 Closed Conduit Flow

5.1.1 Size of Drains: Shall be established as follows:

$Q = a\ v$ where:

Q = Quantity of flow in cfs.

a = Required area of conduit in square feet

v = velocity in feet per second

5.1.2 Velocity: Shall be determined by the Manning Formula:

$v = \frac{1.486}{n} r^{2/3} s^{1/2}$ where:

n = coefficient of roughness

r = hydraulic radius in feet = $\frac{\text{cross-sectional area}}{\text{wetted perimeter}}$

s = slope of hydraulic gradient in feet per foot

5.1.3 Minimum and Maximum Velocities: The minimum velocity shall be 2 fps, and the maximum velocity shall be based on boundary surface material and shall not exceed 25 fps.

5.1.4 Manning's Coefficient (n): The selection of a friction coefficient involves a consideration of not only the initial but also the future conditions of the boundary surface material. Also hydraulic conditions such as velocity and disturbing influences such as joints, alignment, variations in cross-sections, etc. will affect selection. Design values for man-made conduits are given in Table 3.

5.1.5 Hydraulic Gradient: The hydraulic gradient is a line connecting points to which water will rise in manholes and inlets, etc. throughout the system during the particular design flow. The hydraulic gradient shall begin at the downstream end of the proposed drainage system. Where a proposed drainage system is connected to an existing system, the hydraulic gradient at the point of junction shall be determined from existing plans on file with the Office of Planning and Zoning.

Where there are no record drawings available which indicate the elevation

of the existing hydraulic gradient, it shall be the Engineer's responsibility to determine this elevation.

Closed conduit design shall be based on the hydraulic grade line method with pipes assumed to be flowing full. The losses are applied through the structures. The losses are identified and applied as follows:

a. Loss at entrance

$$h_e = Ke \frac{V^2}{2g}$$

b. Loss due to bends

$$hb = K_b \frac{V^2}{2g}$$

c. Loss at Junctions

The controlling angle is used to calculate the loss at the structure.

d. Loss for the length of the pipe.

One equation that can be used is:

$$h_L = 2.87\ n^2 \frac{LV2}{{}_d 4/3}$$

5.2 Open Channel Flow

5.2.1 Size of Required Waterway

The waterway area required shall be determined from the relationship:

$$Q = AV \text{ and Mannings Formula } V - \frac{1.486}{n} r^{2/3}{}_s{}^{1/2}$$

5.2.2 Minimum and Maximum Velocities

Minimum velocities for improved channels shall be 3 fps. The maximum velocities will be controlled by the erodibility of the lining. The maximum

velocity shall not normally exceed 25 fps for non-erodible lining. For allowable velocities in erodible and non-erodible channels, see Table 5.

5.2.3 Manning Coefficients (n)

Design values for man-made channels are well established and are given in Table 3. Natural channels are subject to more variants and present a complex problem. For an extensive treatment of natural channels, the Engineer is referred to Chow, V.T. "Open Channel Hydraulics."

5.2.4 Water Surface Profiles

a. Improved Sections: The solution of the Manning equation often involves a trial-and-error process. However, numerous tables, graphs and capacity charts are available for a variety of channel slopes to facilitate computation, and any of these expedients resulting in sufficient accuracy may be used for design.

b. Natural and Irregular Sections: Streams and channels with irregular and varying "n" coefficients are usually analyzed by the following methods:

1. Standard Step Method: For sample computations, the designer is referred to King, H.W. "Handbook of Hydraulic" and Chow, V.T. "Open Channel Hydraulics."

2. U.S. Army Corps of Engineer Computer Program HEC-2 may be used for design without documentation, providing a complete listing of all input data, including cross-sections, is furnished along with the complete printout.

5.3 Energy Dissipators and End Treatment

5.3.1 Determination of Maximum Outlet Velocity

In all cases, the partial depth velocity shall be checked to determine the maximum outlet velocity to be used in the design of the end treatment.

5.3.2 Drop Structures

One of the most effective means of dissipating energy in channels is the drop structure (abrupt or steeply sloping). Whichever method is employed, sufficient data is to be furnished to support the design.

5.3.3 Stone-Filled Wire Baskets (Gabions)

Wire baskets of various sizes offer an effective means of dissipating velocities at the ends of structures and/or to construct checks or drops in channels. The Engineer is referred to Federal Highway Administration Hydraulic Design Series Nos. 11 and 15 for more specific design criteria. Sizing the stone is critical and will require design and analysis of the velocities for various states of flow. Wire baskets shall be vinyl coated.

5.4 Culverts

5.4.1 Losses Through Culverts

The determination of losses through culverts is well documented in various texts. The Engineer is referred to the FHWA Hydraulic Design Series Nos. 5 and 10 and the U.S. Army Corps of Engineers Computer Program HEC-2 for specifics concerning the design of these structures.

5.5 Bridges

5.5.1 Losses Through Bridges

The determination of losses or the amount of backwater produced through a bridge is complex, and the Engineer is referred to FHWA Hydraulic Design Series No. 1, "Hydraulics of Bridge Waterways" and the U.S. Army Corps of Engineers Computer Program HEC-2 for specifics concerning the design of these structures.

The minimum freeboard between the underside of the superstructure and the design high water shall be 2 feet, based on the 100-year frequency storm with ultimate development using current zoning.

5.6 Reservoir Routing

5.6.1 Drainage Areas Less Than 2,000 Acres

These shall be designed in accordance with the NRCS criteria established in Technical Release No. 55, Engineering Memorandum No. 378, and Engineering Memorandum No. 2.

5.6.2 Drainage Areas Greater Than 2,000 Acres

The design method shall be approved by the Office of Planning and

Zoning.

6.0 COLLECTION AND CLOSED SYSTEM DESIGN

6.1 Specific Design Criteria

6.1.1 Design Storm Criteria

a. Minor drainage systems with flows of less than 10 c.f.s. shall be designed for the 10-year storm as a minimum, except as required in 6.1.1.(b) (c) (d) and Section 7.0.

b. When a closed conduit system is installed to replace an open swale drainage system serving drainage areas of 25 acres or more and/or having a 10-year discharge of 100 cfs or more, the system shall be designed for the 100-year storm.

c. Culverts and/or bridges which are in the 100-year floodplain shall pass the 100-year design storm. The ultimate conditions 100-year storm shall not have more than a one-foot increase in backwater above the existing conditions. A one-foot freeboard is required for the ultimate conditions 100-year storm.

d. The following minimum storm frequency criteria must be met for storm drain systems and culverts:

1.	Cul-de-Sac Street	10 year
2.	Local Road	10 year
3.	Collector Road	25 year
4.	Arterial Road	50 year

In the event the City believes that a greater year storm frequency should prevail for the design of storm drain systems due to concerns over excessive private or public property damage, disruption of public services, flood damage, or other undesirable impacts that may result from implementing the minimum criteria described herein, the City, at its sole discretion and with the approval of the Planning Commission, may require more stringent criteria be followed in the design.

The roads cannot be flooded on the above storm frequency. The water surface elevation should be a minimum of one-foot below the outside edge of the shoulder.

e. The inlet spacing shall be based on the 2-year ultimate condition storm and an eight foot (8') maximum spread onto the pavement measured from the face of the curb.

6.1.2 Basic Equations

a. $Q = A_1V_1 = A_2V2$

Q = Discharge in cfs

A = Cross-sectional area in ft^2

V = Velocity in fps

The subscripts designate different channel or conduit sections.

b. $V = \frac{1.49}{n} R^{2/3} S^{1/2}$

V = velocity in fps

n = Manning coefficient

R = Hydraulics radius in ft.

S = Friction slope in ft/ft.

c. For pipes flowing full

$V = \frac{0.59}{n} D^{2/3} S^{1/2}$

6.1.3 Minimum and Maximum Velocities

a. The minimum velocity in storm drains shall be 2 fps.

b. The maximum velocity in storm drains shall be 25 fps.

6.2 Hydraulic Design Criteria

6.2.1 Hydraulic Grade Line Method

Closed conduit systems shall be designed by the hydraulic grade line method which assumes pipes to be flowing full. In this method, structure losses are approximated by nearly constant functions of velocity head of the incoming or outgoing flow. The losses are applied through a structure.

The hydraulic grade line in a structure or access point shall be below the top of the grade or curb's opening for the design storm and at or below the curb for the 100-year storm.

6.2.2 Future Extensions

Consideration shall be given to possible future extensions of the system.

6.3 Gutter and Street Flow

6.3.1 Flow Spread Requirements

Maximum permissible spread for flow in a curbed street shall be eight feet (8') for the two-year ultimate condition storm event.

Computations shall be based on the following equation:

$$\frac{Q_n}{y^{8/3}\, S^{1/2}} = 0.56$$

Q = discharge in cfs

Z = the reciprocal of the pavement cross slope or side slope in ft/ft
For example, for 1/4"/ft or 2.08% cross-slope, Z = 48)

n = Manning coefficient (normally 0.015 for pavement)

S = gutter slope in ft/ft

y = depth of flow in feet

6.3.2 Gutter Capacity

The gutter capacity cannot be exceeded; i.e., the curbs cannot be overtopped for the 100-year storm.

6.4 Inlet Design

6.4.1 Type of Inlet

State Highway Administration (SHA) Standard COG or COS inlets must be used where curbs are either existing or proposed. Grated inlets shall be SHA WR bicycle safe grates and shall generally be used only in pavement swales such as occur in parking lots and alleys or yard areas.

6.4.2 Where Required

Inlets shall be constructed in all sumps, regardless of flow volume, and at all intersections where flow exceeds 2 c.f.s. or the spread onto the pavement exceeds eight feet (8') and at intermediate points along street where criteria for gutter capacity will be exceeded. Pipes shall have a capacity equal to or greater than design flows, and inlets shall intercept a minimum of 85 percent of the design flow. Any carry-over flow must be accounted for at the next downstream inlet and shown on the Engineer's calculations.

6.4.3

Weep Holes or other temporary measures shall be installed in the catch basins for interception of runoff from the street until the final hot mix asphalt surface coarse has been installed or at the direction of the City or Sediment Control Inspector.

6.5 Closed Conduit Design

6.5.1 Manholes

a. Where used: Shall be used at all change in pipe size and where there is a change in direction.

b. Spacing: Maximum spacing of manholes shall be 400 feet.

c. Alignment: The horizontal alignment of pipe shall be straight line between access points and perpendicular to the road centerline if the pipe crosses the road, wherever feasible. At all inlets, manholes, etc., the invert of the pipe's upgrade shall be a minimum of 0.1 foot above the invert of the pipe downgrade.

6.5.2 Clearance with Other Utilities

For drains nearly parallel to other utilities, a minimum physical horizontal clearance of 5 feet shall be maintained. A minimum physical vertical clearance of 18 inches shall be maintained. Clearances less than this must be approved by the Office of Planning and Zoning.

6.5.3 Minimum Cover

Minimum cover for pipe in roadway shall be 18 inches, measured from the top of the pipe to the finished grade.

6.5.4 Size of Drains

Closed conduit systems shall be sized pursuant with the preceding hydraulic criteria, and the minimum pipe size shall be 15-inch diameter or equivalent.

6.5.5 Materials

All storm drain pipe shall be reinforced concrete pipe, Class III minimum, and required to meet State Highway Administration bedding conditions. Pipe joints shall be sealed with o-ring rubber gaskets.

The following minimum construction methods shall apply:

a. Backfill under the haunches of the pipe shall be hand-placed and tamped.

b. The backfill shall be placed in 6-inch layers equally on each side of the pipe and shall be thoroughly compacted to a minimum of 95% Modified Proctor Density in pavement areas and 90% in unpaved areas.

6.5.6 Foundations

In all cases, adequate bedding conditions shall be provided for drains. The Engineer shall detail on the Plans acceptable methods for supporting drains on unstable soil or fresh fill. Soil borings shall be taken if it is presumed that rock exists in the area or the suitability of material must be determined in order to adequately design the facility. A minimum of 3 inches of gravel bedding shall be placed below the pipe and bedded in gravel up to the spring line of the pipe.

6.5.7 Pipe Loadings

a. Foundation Designs in Specific Locations: Borings will be required for foundation designs in locations where the quantity of runoff requires a 72-inch diameter pipe or larger waterway area. The Engineer shall be governed by the analysis and recommendations of the Soils Engineer for foundation or pipe bedding designs.

b. Pipe Depths and Widths: In locations where the width of pipe trenches exceeds the standard maximum trench width, the loading on the pipe equals a projecting condition, and the design shall be based on positive projecting pipe loadings.

c. For Designs not Included Herein: The design of pipes and/or conduit shall be in accordance with the method presented in ASCE "Design and Construction of Sanitary and Storm Sewers", Chapter 9, Structural Requirements.

7.0 OPEN CHANNEL DESIGN

7.1 Swales, Roadside and Shoulder Ditches

These and other minor waterways having a design flow of less than 10 cfs shall be designed based on a 10-year storm frequency except as required in Section 6.1. All other open channels, improved or natural, shall be designed based on a minimum 50-year storm frequency or consistent with the criteria described in Section 6.1.1(d). Open swales or ditches shall not be used to convey storm water from a drainage area greater than one acre in surface area unless an open swale or ditch is necessary at the terminal end of the system to transition to an acceptable outfall, as discussed in Section 1.3(i).

7.2 Waterway Depth

Maximum waterway depth for all improved channels shall be two (2) feet.

7.3 Freeboard

Generally, freeboard shall be 30 percent of the design depth. This is an approximation. The minimum freeboard shall be 1.0 foot.

7.4 Velocities

a. For non-erodible linings the maximum velocity shall be 25 fps and the minimum velocity shall be 3 fps.

b. For vegetative and natural linings, see Table 5.

7.5 Open Channel Design Criteria

a. The design storm will be based on ultimate development.

b. The time of concentration will be based on:

1. the replacement of hydraulically inadequate bridges and/or culverts upstream of the project or within the project.

2. ultimate development.

c. Manning's coefficient based on

1. existing conditions unless changes in the coefficient are included in the proposed project.

2. the highest seasonal variation of the coefficient.

d. For improved channels, the profile and velocities of the natural stream shall be examined, both upstream and downstream of the proposed development for the following locations:

1. at the beginning and end of the improvement for all projects,

2. five (5) feet for all projects,

3. two hundred (200) feet for projects with drainage areas less than 50 acres,

4. five hundred (500) feet for projects with drainage areas between 50 and 200 acres,

5. one thousand (1000) feet for projects with drainage areas greater than two hundred (200) acres.

e. Riprap for energy dissipators and for bend locations shall be sized for the

100-year storm velocity.

f. If the headwall or bridge height above the channel bottom exceeds five (5) feet, or is within three (3) feet of a sidewalk, then channels which do not require a safety fence shall be provided with guard rails, or other safety device.

g. In non-erodible channels, the flat bottom may be sloped one to two percent to the center to define a low-flow channel.

h. The waterway depth based on the design storm shall be two (2) feet or less for all improved channels.

i. The minimum longitudinal slope of open drainage swales shall be 1.0 percent.

8.0 CULVERTS

8.1 Guardrails, Fences and Pipe Rails

Safety devices shall be required at all headwalls, as deemed appropriate by the Planning Commission.

8.2 Structural Borings

Structural borings to determine character and bearing capability of in-site material underlying foundations shall be provided for all single cell or pipe culverts of an opening size greater than twenty (20) square feet.

For the purpose of this design manual, a culvert shall be defined as a structure under a roadway or other embankment, open at each end, placed for the purpose of conveying a natural stream, waterway, or storm drainage.

8.3 Culvert versus Bridge

In general, the City of Brunswick will only approve culverts for stream crossings. If the Developer or his Engineer believes that only a bridge structure will satisfy the hydraulic, environmental and other prevailing criteria, the Engineer shall submit written analysis comparing the use of culvert and bridge. The analysis should include capital costs, maintenance costs, traffic maintenance, soil conditions, rights-of-way, and hydraulics and environmental impacts.

8.4 Inlet Protection

The inlet of all culverts shall be provided with a headwall or some other acceptable means of terminating the pipe and protecting the culvert from erosion.

8.5 Outlet Protection

It shall be the Engineer's responsibility to determine the need for erosion protection at the culvert due to excessive velocities. Outlet velocities shall be compared to stream velocities at the site under consideration to determine the need for erosion protection. The Engineer shall furnish data which supports the lack thereof for erosion protection.

8.6 Structural Design

The structural design of reinforced concrete box culverts shall be in accordance with the "Standard Specifications for Highways and Bridges", adopted by AASHTO. Culverts shall be sized using FHWA Design Series 5 and 10 and the U.S. Army Corp of Engineer's Computer Program HEC-2.

8.7 Minimum Freeboard

The minimum freeboard between the underside of the superstructure and the design storm water surface elevation shall be one (1) foot. The headwater of the structure shall be as close to the existing water surface elevation as possible. In trout streams, one culvert shall be one (1) foot lower than the final grade elevation.

8.8 Minimum Length

The minimum length of the culvert shall be based on providing for a 1/4 inch per foot graded area eight feet (8') behind the curb or two feet (2') behind the sidewalk, whichever is greater, and a side slope of 3:1 from this point.

9.0 BRIDGES

9.1 General

Bridge design is too broad a subject to be treated herein. However, the following guidelines are to be considered.

9.1.1 Where Used

Bridges shall be used for those cases where:

The quantity of flow to be passed is too great for a culvert;

Obstructions on the floodplain are to be avoided; or

Preservation of natural stream conditions is warranted.

9.1.2 Minimizing Lateral Forces

To minimize lateral forces on the structures, water must pass beneath the bridge without a standing headwater pool as is normal for a culvert. This requires the superstructure to be raised higher than that of a comparable box culvert.

9.1.3 Problems for Waterway Openings

Two of the foremost problems with bridge construction for waterway openings are the protection of the substructure from scour and erosion and the minimization of waterway obstruction. The placing of abutments and piers in the deepest flowing parts of the stream is prohibited.

9.1.4 Additional Considerations

a. To minimize accumulation of debris, stream crossings shall have as few supports in the waterway opening as possible, and all should be avoided if the flow is super-critical.

b. Embankments and grading around the substructure of a bridge shall be protected where necessary with either cast-in-place concrete slope protection or other acceptable methods.

c. The entire substructure of a bridge should be fitted in with the natural layout of the channel in such a way that hydraulic disruption is minimized.

d. The leading and trailing edges of piers in the stream should be either rounded or wedge-shaped to pass the water with a minimum of resistance and reduce possible scour from eddy currents.

e. Bridge design shall be in accordance with the "Standard Specifications for Highway Bridges", adapted by AASHTO officials, current State Highway Administration practices, and the current Maryland Department of the Environment regulations. Plans shall show all pertinent structural data such as design loadings, pressures and allowable stresses.

9.1.5 Piers and Abutments

The depths of bridge piers and abutment footings shall be established with respect to the character of the foundation materials and the possibility of undermining as determined from structural borings and soundings.

9.1.6 Footings

Except where solid rock is encountered, or in other special cases, footings which are exposed to the erosive action of stream currents, preferably shall be founded at a depth of not less than 8 feet below the stream bed. The above preferred minimum depths shall be increased as conditions may require. Footings not exposed to the action of stream currents shall be founded on a firm foundation and below the frost line.

10.0 ENERGY DISSIPATORS AND CHANNEL PROTECTION

10.1 Drop Structures

One of the most effective means of dissipating energy. Sufficient data must be furnished to support design.

10.2 Gabions

Wire baskets of various sizes offer an effective means of dissipating velocities at the ends of structures and/or to construct checks or drops in channels. Gabion wire baskets shall be vinyl coated in all cases.

10.3 Riprap

Stone may be used to dissipate velocities at the ends of structures and to line channels. The stone is to be sized for the design storm's velocity.

STREETS AND ROADS DESIGN

STREETS AND ROADS DESIGN CHAPTER

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STREETS AND ROADS DESIGN CHAPTER

1.0 GENERAL

1.1 Definitions

a. In these Standards, the terms "roads and streets" identifies any public highway, thoroughfare, road, street, cul-de-sac, or service road. The term "highways" identifies traffic ways under the jurisdiction of the Maryland State Highway Administration.

b. Service Road: A local access road to provide a means of egress and ingress to a non-residential development for the purpose of limiting access directly onto a collector or arterial roadway. The minimum right-of-way and pavement width shall be 40 feet and 24 feet, respectively.

c. Local Road or Street: The local street comprises all facilities not in use of the higher order systems. It is intended to carry the least amount of traffic at the lowest speed and provide the safest and most desirable environment for a residential neighborhood, with the maximum number of homes fronting the street. The local street provides access to land adjacent to the collector network and serves travel over relatively short distances. The minimum right-of-way and pavement width shall be 50 feet and 30 feet, respectively.

d. Collector Road or Street: This is the highest order of street that could be classified as residential. This class of street is necessary to carry traffic from one neighborhood to another or from the neighborhood to streets connecting to other areas in the community. Direct access to homes is discouraged onto collector roads. The minimum right-of-way and pavement width shall be 60 feet and 34 feet, respectively.

e. Minor Arterial: This classification of roadway generally provides for movement of vehicles larger in number than collectors and local roads, with no direct access from homes allowed. This classification of roadway receives volumes of traffic from collectors and provides inter- and intra-county access throughout the municipality and county. The minimum right-of-way and pavement width shall be 80 feet and 40 feet, respectively.

f. Major Arterial: This is the highest order of street or road. This classification of roadway carries the highest volume of traffic through the municipalities and county and does not provide for direct access from homes or commercial

development. The minimum right-of-way and pavement width shall be 100 feet and 48 feet, respectively.

g. (ADT) Average Daily Traffic: The total volume of traffic during a given time period (in whole days), greater than one day and less than one year, divided by the number of days in that time period.

h. Peak-Hour Traffic: The volume of traffic during the hour of day with the highest volume. For design purposes, this should represent the 30th highest hourly volume of the year, or 30 HV, and generally represents 15% - 25% of the ADT.

i. Design Speed: The maximum safe speed that can be maintained over a specified section of road or street when conditions are so favorable that the design features of the road govern.

j. Capacity: The maximum hourly rate of traffic at which persons or vehicles can reasonably be expected to traverse a point or uniform section of road during a given time period under prevailing roadway and traffic conditions.

k. Stopping Sight Distance: The length of roadway ahead visible to the driver. Stopping sight distance is the sum of two distances: the distance traversed by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied; and the distance required to stop the vehicle from the instant the brake application begins. These are referred to as brake reaction distance and braking distance, respectively.

l. Passing Sight Distance: The length needed to safely complete normal passing maneuvers, generally determined for a single vehicle passing a single vehicle. The minimum passing sight distance for two-lane roads is determined as the sum of the four distances:

    1. Distance traversed during perception and reaction time during the initial acceleration to the point of encroachment on the left lane.

    2. Distance traveled while the passing vehicle occupies the left lane.

    3. Distance between the passing vehicle at the end of its maneuver and the opposing vehicle.

    4. Distance traversed by an opposing vehicle for two-thirds of the time the passing vehicle occupies the left lane, or 2/3 of "2" above.

m. AASHTO: American Association of State Highway and Transportation Officials.

n. Alley: A public right-of-way which affords only a secondary means of access to abutting properties.

o. Level of Service: The degree of traffic congestion as determined by methodology contained in the *Highway Capacity Manual*.

1.2 Responsibility for Design and Construction

a. City roads and streets in or related to new development are designed by Developers or their consulting engineers. City projects are designed by either the City or consulting engineers.

b. Construction of roads and streets in or related to new development is the responsibility of the Developer. These projects are constructed by either a contractor hired by the Developer or the Developer's own forces with rights-of-way deeded to the City.

c. The Developer shall provide the City with a minimum one-year warranty from the date of acceptance of the improvements by the City for all work constructed by the Developer. The City shall withhold all of the contingency portion of the surety associated with road work (i.e. paving, curb and gutter, sidewalk) until the warranty period expires.

d. The City will not accept the road improvements until all construction is complete, final paving is installed, build-out is complete, and there is no longer a need to use the completed road for construction traffic. No construction traffic will be permitted on streets that have been accepted by the City. If phased, only that phase must be complete. A temporary turnaround may be requested at end of each phase but not accepted by the City.

Any street, cul-de-sac, alley or public right-of-way must meet the requirements of the Brunswick Subdivision regulations, Design Manual and other applicable standards and specifications to be taken into the Municipal Street System. The City of Brunswick is not obligated to upgrade any street, cul-de-sac, alley or public right-of-way to these standards unless it is deemed advisable to facilitate traffic flow or to address a public safety matter.

1.3 Authorization Permits

a. Where intersections occur with roadways under the jurisdiction of the Maryland State Highway Administration, Frederick county, or other political districts, a

permit from the office involved authorizing the proposed construction must be filed with the City before plans will be approved.

b. Where permits are required from other agencies, such as the Natural Resources Conservation Service, Maryland Department of the Environment or Army Corps of Engineers, a signed permit from those agencies having authorization over the project must be filed with the City before plans will be approved.

1.4 Planning Guidelines

The designation or classification of the road, street or alley shall be designed as stipulated in the City's Comprehensive Plan or as dictated by the City. The design standards of roads and streets as shown herein shall be used. In the event a development is submitted for review to the Planning Commission as a Planned Unit Development (PUD), the Planning Commission, at its discretion, may alter the design standards herein as they deem appropriate. In the event a conflict exists between the requirements, the more stringent applies.

1.5 Existing Streets

Each street abutting or affecting the design of a subdivision or land development which is not already classified in the comprehensive plan shall be classified to its function, design and use by the City at the request of the applicant or during plan review. The classification of existing streets shall include the hierarchy noted above or classification of higher order, as determined by the City.

2.0 DESIGN

2.1 Preliminary Considerations

The design of roads and streets includes general layout, curb and gutters, signage, sidewalk, alignment, grades, grading, paving widths, paving material, and drainage facilities. Sufficient rights-of-way should be set aside in the early stages of layout to provide for future increases in pavement widths and roadside improvements when practical. When determining alignments and grades of roads and streets, the designer must consider the requirements for utilities, including adequate storm drainage, and he must take into account any unusual aspects of the design, such as railroad crossings, floodplain crossings, intersection improvements with State or County roads and traffic signals.

2.2 Layout of Intersections

a. Centerlines of traffic ways shall continue through intersections without

offsets and shall intersect as nearly as possible at right angles. Where various conditions make a right angle intersection impracticable, the minimum deflection angle between the centerline of a street and the centerline of any other street shall be 60 degrees or 70 degrees when intersecting State Roads.

b. There must be an unobstructed sight distance along all approaches at an intersection across their included corners for a distance sufficient to allow operators of vehicles to accelerate, slow down, or stop. The design is commonly called the intersection sight triangle. All intersections should be designed with angle of intersection at 90 degrees. AASHTO's discussion of intersection sight distance shall predominate, but is too long to be included here. Since local residential access streets will inherently be low speed roads, then one can plan on only having to satisfy AASHTO's requirement for 30 mph situations. Stopped intersections of local roads shall have a minimum sight distance of 150 feet. AASHTO's guidelines, as discussed in A Policy on Geometric Design of Highways and Street, latest edition, Chapters 5, 6, and 7, will govern except as modified in this design manual.

c. At the intersection of two (2) closed section streets, consideration must be given to the radius of the return. A minimum curb radius of 20 feet should be provided with 25 feet minimum at the intersection with State or County highways.

d. At an intersection of an alley and a street, the standard radius of the return shall be 10 feet to face of curb. Where the distance on the street between the face of the curb and property line is less than 10 feet, that distance shall become the return radius.

e. Where alleys intersect at 90 degree angles, the fillet triangle formed shall have legs of 15 feet. At intersections other than 90 degrees, the fillet triangles shall be subject to approval by the City.

f. The cut-back of property lines at intersections shall be governed by the following criteria:

1. At an intersection of roadways (other than alleys), the cut-back of the property line normally shall be a chord connecting the points on the property lines directly opposite the Point of Curvature (P.C.) and Point of Tangency (P.T.) of the curb return or edge of pavement return. In any case, the minimum distance from the property line Point of Intersection (P.I.) at an intersection and the property line chord points shall be a minimum of 10 feet.

2. At an intersection of an alley and a street, the property line shall not be cut-back.

3. At an intersection of alleys, the property line shall conform with the pavement fillet.

g. A clear zone should be established that is free of all opaque obstructions greater than 3.0 feet high above the curb elevation. Such objects typically include: buildings, cut slopes, hedges, trees, bushes, or tall crops. The triangular dimensions of the zone allow for the desired sight lines. This triangle shall have a minimum of 35 feet dimension on the edge of the pavement on both legs. This distance may be increased by the City if deemed appropriate for safety reasons. This design requires elimination of parking within the sight triangle. Street signs, fire hydrants, and utility poles typically can be located within a sight triangle, as long as they are not clustered and do not contribute to sight limitation.

h. Intersections shall be no less than 250 feet apart between roadway centerlines. (Local streets only.)

i. Refer to Table 2 in the Appendix for separation guidelines.

j. In certain situations, the design and construction of turning lanes or acceleration/deceleration lanes at intersections may be required to facilitate the movement of traffic through an intersection and improve traffic capacity and level of service. The Planning Commission reserves the right to require additional lanes of roadway for this purpose and to require additional rights-of-way to accommodate the additional lanes. Intersections will be reviewed on a case-by-case basis, and a final determination made by the Planning Commission as to the necessity for and the geometric requirements for additional turning lanes.

k. Intersections of more than two (2) streets at an intersection shall be prohibited.

2.3 Horizontal Curves

a. Where road and street centerlines change direction by more than one degree (1°), they shall be connected by a horizontal curve with a radius to insure a minimum horizontal sight distance, as shown in Table 1. Minimum radii of horizontal curves shall be limited as directed by the Table's minimum radius. The minimum radius of a horizontal curve shall be 150 feet.

b. Property lines which change direction through angles less than one degree (1°) need not have a horizontal curve introduced at the break, unless otherwise directed by the City.

c. Horizontal curve data shall be computed by the arc definition of a circular curve. A tangent of at least 100 feet shall be used between reverse curves. Horizontal alignments using compound curves shall be avoided.

2.4 Superelevation

Horizontal curves of road and streets in subdivisions, commercial and industrial areas, regardless of classification, shall not be superelevated.

2.5 Cul-de-Sacs; Tee Turn-Arounds; Driveways

2.5.1 Cul-de-Sacs

a. Generally, all residential parcels should be accessible from two directions. This usually reduces total vehicle miles of travel and improves emergency vehicle access. However, the most efficient subdivision of certain tracts (considering shape and terrain) may work best by locating limited numbers of lots along dead-end streets.

b. An 800-foot length shall be the maximum for cul-de-sacs unless otherwise approved by the Planning Commission. The minimum right-of-way radius for a traditional circular cul-de-sac is 50 feet. No eyebrow cul-de-sacs shall be permitted. The minimum length of a cul-de-sac shall be 350 feet from the centerline of the intersecting street to cul-de-sac curb. The minimum outside pavement/curb radius is 40 feet. Larger cul-de-sacs will be required in subdivisions with very large lots with sufficient lot width to allow curb parking around the cul-de-sac. The curb parking creates the need for larger pavement/curb radii to accommodate the parking, while providing sufficient turning radius for large trucks and fire apparatus. Oversized cul-de-sacs will also be required for school bus access, as determined necessary by staff at the preliminary plan stage. The minimum diameter of the right-of-way for over-sized cul-de-sacs, when required by the City, shall be 150 feet.

c. When outside curb (pavement) radii of 40 feet or greater are used, they create large expanses of pavement which may be unsightly. The use of center islands may be considered to reduce this paved area, if care is given to keeping adequate maneuver space around the island. A minimum pavement driving width of 20 feet is required around the island. The use and design of islands will be at the discretion of the Planning Commission. All islands, when approved by the City, will be rolled curbed.

d. In addition to the traditional circular cul-de-sac, an offset cul-de-sac may be provided. Generally, offset cul-de-sacs are used to overcome environment, topographic and property constraints.

e. At the connector between the cul-de-sac right-of-way, a transition radius is required. This radius should be at least 50 feet, to avoid an unsightly sidewalk layout and to provide smooth turning movements into and out of the cul-de-sac. Also, a more constant curb to right-of-way line dimension is achieved.

2.5.2 Tee Turn-Arounds

Tee Turn-Arounds will not be permitted as temporary or permanent facilities.

2.5.3 Driveways

Layout of driveway entrances shall conform with the applicable Typical Driveway Entrance Detail, shown in the Appendix.

2.6 Design Speed

Designation of a design speed is suspended here because other design elements serve to "limit" speeds in residential areas. Wherever possible in the other sections, an effort to design for 30 mph or less has been considered. Lower design speeds must be considered as progressively more difficult terrain is encountered.

The Developer or his Engineer shall submit with each project a proposed mechanism or method(s) for reducing traffic speed on the roadways being designed, particularly in residential areas. The mechanism or method(s) to achieve the desired result of reducing traffic speeds may consist of one or more different approaches.

2.7 Minimum Centerline Radius of Curves

The minimum centerline values for design of streets and roads are provided in Table 1. These values relate to mid-block horizontal centerline curves and not to intersection radii.

2.8 Minimum Tangent Between Reverse Curves

A minimum tangent of 100 feet at curves and intersections is needed between reverse curves to facilitate steering and control. Refer to Table 1 for minimum lengths for various roadway classifications.

2.9 On-Street Parking

a. Off-street parking requirements are addressed in the zoning and subdivision regulations. However, the adequacy of street widths is tied to available off-street parking and the need to provide on-street parking capability when off-street parking is not sufficient. The pavement widths provided in Table 1, and as shown in the Standard Details in the Appendix of this manual, provide the opportunity for on-street parking.

b. Studies have shown curb parking to be a primary factor in accidents on all types of streets. The number of children killed and injured each year as a result of entering the street from behind parked cars is particularly tragic. For these reasons, every development must meet off-street parking requirements so as to minimize curb parking.

c. Angle parking along the curbs of local streets should not be allowed. When traffic lanes are used for parking and parking maneuvers, the accident potential is much higher than with parallel parking. Therefore, all such bays and lots allowing any parking other than parallel, should be physically separated from the roadway and confined by barrier curbing beyond the street and the sidewalks.

2.10 Driveway Aprons

a. Because they are deceptively simple in appearance, driveway aprons often do not receive the design consideration that they merit. Common deficiencies include:

1. Inadequate radii at intersection with street;

2. Excessive grades and grade changes (breakover angles);

3. Inadequate width and depth of paving;

4. Inadequate sight-distance due to landscaping;

5. Poor drainage characteristics.

b. The typical residential driveway apron should be designed for passenger car operation only. The driveway radius or flare should be designed with consideration given to both the driveway and road width. Refer to the Standard Details in the Appendix of this chapter for a typical driveway apron design.

2.11 Minimum Tangent Length Approaching Intersection

It is desirable to provide a tangent section of roadway approaching intersections, when the street leg has minimum or near-minimum radius curve. However, curving collector streets need not have tangents approaching intersections with local streets, if the collector radius is 1,000 feet or greater.

2.12 Drainage Structures

a. Inlets or catch basins should not be located within the corner radius or within 6 feet of either end. Clearance is needed to keep the area relatively dry and to allow space for street lights, name signs, utility poles, etc. Grate design should provide for safety of bicycle traffic.

b. Special considerations should be given to the middle of the curb return at the upper end of the intersection of two streets in a downhill condition. A small area of ponding in the gutter can be created due to the gutter slope. Detailed spot elevations must be provided to show that all drainage will flow to the appropriate storm drain inlet.

2.13 Traffic Control

All signs, including stop signs and street identification signs, will be placed by the Developer at the expense of the Developer, according to the Manual of Uniform Traffic Control Design (MUTCD). All intersections of City roads and streets with other private or public streets, with the exception of State and County roads, are under the jurisdiction of the City of Brunswick. Intersections at State facilities are under Maryland State Highway Administration jurisdiction. On City roads and streets, the curbs shall be painted to identify or prohibit parking. At a minimum, this will generally require painting 7.5 feet on each side of a hydrant and along the curbed radius to a point 20 feet beyond the end of the radius in each direction. Centerline road markings will be required on all roads and streets except local roads. Stop lines will be required on all roads and streets at stop signs. Crosswalks will be required.

2.14 Commercial Driveway Entrances

a. The minimum width of a commercial driveway access shall be 30 feet.

b. Median-divided entrance roads are permitted; however, they must meet a minimum 100-foot depth. The median width may range from 4 feet to 10 feet. The minimum drive-aisle width shall be 14 feet. Any other non-standard design (channelization, right-in, right-out, angled entrances, etc.) must be approved by the City on a case-by-case basis.

c. In all cases, the minimum curb return of radius shall be 25 feet and shall have curbed edge protection. Larger radii are recommended for larger design vehicles.

d. For all commercial driveways having access to higher volume, higher classified roads, the City can require that acceleration/deceleration lanes and bypass lanes with additional right-of-way be provided. When required by the City, a sufficient bypass lane design shall include, as a minimum onto a collector road, a 150 feet departure taper, a 150 feet bypass, a 100 feet transition, and a 150 feet

merge taper. When access is onto a minor or major arterial, a 300 feet departure taper, a 300 feet bypass, a 200 feet transition, and a 300 feet merge taper shall apply. The bypass lane shall be a full width lane equal to or greater than the travel lane width.

2.15 Grades

2.15.1 Roadways

a. The minimum allowable grade of roadways shall be 0.50%.

b. The maximum grades of roadways shall be as shown in Table 1.

c. To meet the criteria for cul-de-sacs, the grades across the circular portions of cul-de-sacs shall be flattened when necessary: the grade along the centerline extended across the circular portion of any cul-de-sac shall not exceed a mean of 6%.

d. At an intersection of two roadways, the normal typical section of the priority traffic way shall continue through the intersection without break. The crown of the other traffic way shall be warped from its normal section to connect to the edge of the priority traffic way. Where two traffic ways of equal importance intersect, one shall be considered as a priority traffic way in order to accomplish the foregoing connection, except where the design engineer is unable to determine satisfactorily either one of the intersecting traffic ways as a priority traffic way. In this case, the City shall be consulted.

2.15.2 Intersections with State Roads

Approach grades to Maryland State Highway Administration shall be governed by the State Highway Administration.

2.16 Vertical Curves

a. To avoid an abrupt change in vertical alignment when passing from one grade to another, a vertical curve shall be used at the grade intersection whenever the algebraic difference in the percents of a grade is 0.25 or greater.

b. Elevations on vertical curves shall be computed by the parabolic curve formula, except for rehabilitated streets when it becomes impractical, due to the use of other curves. The elevations of other curves may be scaled when the profile is plotted on a scale of 1 inch = 50 feet horizontal and 1 inch = 5 feet vertical.

c. The minimum length of a vertical curve may include a compound curve, but not a reverse curve, and shall not be less than 100 feet.

d. The parabolic curve is used almost exclusively in connecting grade tangents because of the convenient manner in which the vertical offsets can be computed. Figure 1 in the Appendix provides the Standard Landing Requirements for Local and Collector Streets. A typical symmetrical vertical curve is shown below.

PARABOLIC VERTICAL CURVE

P.V.C.	Point of Vertical Curvature
P.V.I.	Point of Vertical Intersection
P.V.T.	Point of Vertical Tangency
E.	External Distance - in feet
L.	Length of Curve - in feet
g_1	Grade from which stationing starts (in %)
l	1/2 or half the Length of Curve
y	Offset in feet
x	Any Distance from P.V.C. in feet
g_2	Grade toward which station heads (in %)

To design the curve for use in profile drawings, first the minimum allowable length of curve must be established. This minimum length is: K (a constant) multiplied by the absolute value of the algebraic difference of the two grades (in percent). Per AASHTO for a design speed of 30 mph in a crest (1) condition K = 30 and a sag (2) condition K = 40. For other design speeds, refer to Table 1.

(1) A vertical crest is the same as a hill or high point, with the

extensions of the two tangents forming an angle point up.

(2) A vertical sag is the same as a valley or low point, with the extensions of the two tangents forming an angle pointing down.

Other equations that may be helpful are as follows:

Lmin = K x (gl - g2) = Minimum Vertical Curve Lengths

$$E = \frac{(g1 - g2) \cdot L}{800} = \text{Vertical Offset at P.V.I.}$$

$$r = \frac{g1 - g2}{L(\text{in stations})} = \text{Rate of Grade Change}$$

$$y = \frac{r}{2} x^2 + glx + \text{Elevation P.V.C.} = \text{Vertical Offset of any point X Station from the P.V.C.}$$

In order to determine the high (low) point along the curve, use the equation

$$X \text{ (in stations)} = \frac{-gl}{r}$$

e. An effort shall be made to avoid the placing of horizontal curves along crest vertical curves. Where such design is unavoidable, the sight distance of the vertical curve shall not be less than the horizontal curve sight distance, and the limits of the horizontal curve shall extend beyond the limits of the vertical curve.

2.17 Underdrains

To drain free water from subgrades in excavated areas, underdrains shall be incorporated into the design of new roadways wherever there is a possibility of water undermining the traffic way subgrade. See Standard Details 387.01 and 387.11 of the State Highway Administration for Construction Methods.

2.18 Guard Rail

a. Guard rail shall be erected on roadways at points of extreme hazard to a vehicle leaving the traveled portion of the traffic way. Generally, this potential hazard develops at fills over 8 feet in vertical depth from the edge of the curb or right-of-way to the toe of the slope. Guard rail shall be placed behind the curb and sidewalk.

b. Where roadway construction ends in fill areas, temporary barricade posts shall be erected.

c. For guard rail details, refer to the State Highway Administration Construction Details series 660.

2.19 Sidewalks and Curb and Gutters

Concrete sidewalks and curb and gutters shall be required on both sides of all new roadways, regardless of classification. Refer to the Standard Details in the Appendix of this manual for Construction Details and Location.

2.20 Cross Sections and Quantities

a. Cross sections for roadways shall be taken at least every 50 feet and at all noticeable terrain breaks. The centerline and profile grade line shall be stationed correspondingly.

b. The design engineer shall provide quantity estimates to the City. These estimates shall include all quantities for grading, paving, curb and gutter, excavation, embankment, etc., and shall be tabulated as directed by the City.

2.21 Traffic Impact Studies

2.21.1 Purpose

a. Whenever a proposed project will generate one hundred (100) new vehicle trips in the peak direction (inbound or outbound) during the site peak traffic hour, the applicant shall perform a traffic impact study. Based on this study, certain improvements may be identified to provide safe and efficient access to the development. Studies shall be done on normal weekdays, excluding holidays and when schools are in session.

b. In addition, a traffic impact study shall be prepared whenever either one of the following conditions exist within the impact study area:

1. Current traffic problems exist in the local area, such as a high-accident location, confusing intersection, or a congested intersection which directly affects access to the development.

2. The ability of the existing roadway system to handle increased traffic or the feasibility of improving the roadway system to handle increased traffic is limited, as determined by the City.

3. Study is required as a condition of all annexation and rezoning applications.

2.21.2 Traffic Impact Study

The traffic impact study will include and comply with the requirements as contained in Section 2.2 of the City of Brunswick *Adequate Public Facility Ordinance*.

2.21.3 Improvements

2.21.3.1 Responsibility for Improvements

The applicant shall be responsible for the improvements required to provide safe and convenient ingress and egress to the development site.

2.21.3.2 Coordination with Municipal Requirements

The applicant shall be responsible for other improvements as may be agreed to with the City of Brunswick or which are required by any municipal adequate public facilities, impact fee or improvement fee, or other ordinance and which improvements shall be installed or paid for by the applicant.

2.22 Utility Trenching, Backfill and Repaving of Roads

2.22.1 Repaving of Utility Trenches

a. All City construction contract specifications shall include a "patch-pave" requirement as follows:

Properly compacted borrow aggregate backfill shall be placed and compacted from 3 inches below the pipe to the bituminous pavement subgrade. The pavement replacement shall consist of a base course of asphaltic concrete of at least a thickness equivalent to the original pavement section, the original wearing course cut back two-feet on all edges of the excavation and a new asphaltic concrete wearing course of at least a thickness equivalent to the original wearing course. Other road pavement sections will receive similar treatment. The base course shall be a minimum of 4-inches and the wearing course shall be a minimum of 2-inches.

b. Patch-paving as outlined above is to be accomplished whether the roadway is to be re-paved or not.

c. House connection installations will require the same specifications for patch-paving.

d. All paving/re-paving work will be accomplished in accordance with the City Road Specifications or Design Manual. A "road cut" permit must be obtained from the City when excavating within an existing City maintained roadway.

2.22.2 Pipe Bedding, Trench Backfill and Compaction Requirements

a. Bedding: The trench shall be excavated to a minimum depth of three (3) inches below the outside diameter of the pipe, or deeper if so specified. The resultant subgrade shall be undisturbed, or compacted as approved by the Engineer if disturbed. The bedding shall then be prepared by placing a thoroughly compacted aggregage pipe bedding and initial backfill material, consisting of limestone dust, in 6-inch (uncompacted thickness) layers to 2-feet above the top of pipe. Bedding shall provide uniform and continuous bearing and support for the pipe.

b. Backfill Material to Restoration Depth: From two (2) feet above the top of the pipe to restortion depth, the trench shall be backfilled with select aggregate backfill consisting of limestone dust. Backfill in this section of the trench shall be consolidated by tamping in eight (8) inch layers or other approved mechanical methods unless otherwise specified. Any consolidation method utilizing water, such as jetting or puddling, shall not be permitted. Consolidation shall proceed form the center of the trench to the sides to prevent arching. Backfilling shall use equipment and performed in such a manner that will not damage the pipe or joints.

c. Compaction: Use mechanical tampers to compact backfill materials in trench refill operations to produce a density of backfill at the bottom of each layers of not less than 95 percent of maximum density obtained within two (2) percent optimum moisture content as determined by AASHTO T 99. Perform field determinations of density, when requested by the Engineer, in accordance with AASHTO 191. The top twelve (12) inches shall be 100 percent of maximum density in accordance with AASHTO T99. Within State Highways, backfilling and compaction requirements shall comply with those of the State Highway Administration.

In areas other than existing paved streets rights-of-way, future streets rights-of-way, or in any traveled roadway, from a point two (2) feet above the top of pipe to the bottom of topsoil, the backfill shall be placed in not more than twelve (12) inch lifts and solidly compacted by the use of a roller or other mechanical device to a density not less than 90 percent in accordance with AASHTO T 99.

2.22.3 Timing of Patch-Paving and/or Re-Paving

a. Specifications will provide that patch-paving shall be accomplished immediately after backfilling and achieving specified compaction for connection and small extension contracts; and at no greater than seven (7) calendar day intervals for larger projects. Temporary "cold patch" shall be required for patches not immediately patch-paved. The City must be consulted if immediate patch-paving cannot be accomplished. Cold patching must be maintained by the Developer to the City's satisfaction. The placement of steel plates over trenching may be approved by the City on a case-by-case basis.

b. Re-paving shall be specified to be accomplished in one continuous effort to best assure economy and consistency of quality work.

2.22.4 Traffic Control

All utility construction projects shall have an approved traffic control plan, using requirements of the *Manual on Uniform Traffic Control Devices*.

3.0 CONTRACT DRAWINGS AND DOCUMENTS TO BE SUBMITTED TO CITY

3.1 Contract Drawings

3.1.1 General

a. Roadway layouts shall be prepared on sheets separate from other utilities. These drawings shall be made on standard size tracing mylar film, with titling as required by the City, and shall be rendered in black ink.

b. On all Road and Street projects, including improvements to existing roads and where a subdivision abuts on only one side of the road, cross sections shall be taken in the field.

Maximum distance between cross sections shall be 50 feet, with intermediate cross sections taken as needed to show a true picture of the topography. The cross sections shall extend to a point sufficient to determine the slope and other easements.

c. The cross sections shall be plotted on standard cross section paper 10 x 10 graduations to the inch. The scale for plotting the cross sections shall be 1 inch = 10 feet both vertical and horizontal. The original ground line and the proposed road section shall be shown.

d. The plan shall be drawn to a scale of 1 inch = 50 feet or larger. The profile shall be drawn to a horizontal scale of 1 inch = 50 feet or larger and a vertical scale of 1 inch = 5 feet.

e. Drawing numbers of other utilities (water, storm drainage, etc.) being prepared for the development at the same time shall be shown on the plan portion of the roadway drawings.

f. A location map drawn to a scale of 1 inch = 500 feet shall appear on the first drawing of the traffic way drawings. In remote areas, an additional location map on a small scale, such as 1 inch = 2000 feet, shall be required so that existing roadways may be used for orientation reference.

g. The applicant shall submit ten (10) copies of all plans for review by the City. Signature blocks shall be provided for signature by: Natural Resource Conservation Service; City of Brunswick Planning Commission; City of Brunswick Engineer; Frederick County Division of Utilities and Solid Waste Management for Storm Water Management.

h. Three (3) copies of final plans shall be submitted to the Office of Planning and Zoning for use by the City in updating the City's maps.

i. One (1) copy of the As-Built drawings on mylar plan sheets with the statement and Engineer's signature, as shown in the Appendix, shall be submitted to the Office of Planning and Zoning within thirty (30) days of completion and acceptance of the work by the City and on computer or GIS diskette in a format approved by the Office of Planning

and Zoning.

3.1.2 Plan

3.1.2.1 Street Names

The names of all roadways shall be clearly lettered either along the street centerline or along one property line, whichever location is more convenient; however, all names on each drawing shall be placed in the same relative position.

3.1.2.2 Widths of Right-of-Way, Pavement and Easements

Widths of existing and proposed rights-of-way and pavements for each traffic way shall be shown with dimensioning. Slope easement where established and utility easements and rights-of-way which intersect traffic way rights-of-way shall be shown with dimensioning.

3.1.2.3 Topography

The location of all structures above the subgrade shall be shown, all topography, including poles, trees, fences, hedges, property markers, buildings and other structures. This topography shall be carried at least 100 feet beyond right-of-way lines, 200 feet beyond the ends of roadways or beyond approval limits, and 200 feet in each direction from an intersection. When shown, all measurements for utility structures, poles, trees, fences and hedges shall be dimensioned from the roadway centerline.

3.1.2.4 Coordinates, Bearings, and Ties

a. Bearings of roadway centerlines and coordinates of centerline P.C.s and P.T.s and of intersecting traffic way centerline P.I.s shall be shown along the respective centerlines.

b. In addition to the above requirements, all P.I.s, P.C.s, P.T.s and other points that are needed to re-establish the centerline of the traffic way shall be referenced to

permanent features or guarded hub stakes that will not be disturbed prior to the completion of all work.

c. The location and description of all reference points and the distance or angles to the centerline control points shall be shown on all Roads and Street drawings.

3.1.2.5 Horizontal Curve Information

Centerline curve information for each horizontal curve shall be tabulated on the plan in the following manner:

_ = ____° ____' ____" (Angle of intersection)
D = ____° ____' ____" (Degree of curve)
R = ____.____' (Centerline radius)
T = ____.____' (Tangent Length)
L = ____.____' (Length of curve)

_, or Delta, is the external angle of intersection of the tangents at the P.I.

3.1.2.6 Stationing

a. Stationing along the centerlines of tangents shall be in even 100 feet stations, indicated by a small circle and the station number. Stationing along horizontal curves shall be indicated in like manner.

b. P.C.s and P.T.s of horizontal curves shall also be indicated by a small circle on the centerline and their stations shown to the nearest hundredth of a foot.

c. Stations of P.C.s and P.T.s of curbs on circular portions of cul-de-sacs shall be shown on the plan.

d. P.I.s of intersecting traffic way centerlines shall be indicated by a small double circle at the centerline intersection, and the equality to the nearest hundredth of a foot shall be lettered thereunder.

3.1.2.7 Match Lines

Traffic way plan portions shall be continued from one sheet to the next with match lines. In addition, the last 200' of each section of a traffic way plan shall be repeated on the next adjacent section.

3.1.2.8 P.I.s of Curb Lines

The points of intersection of curb lines shall be indicated by small linked crosses and shall be identified thereunder as N.E., N.W., S.W., or S.E.

3.1.2.9 Direction of Drainage

a. Arrows approximately 1/2 inch long shall be drawn around all curb returns and at all critical drainage points to indicate the direction of surface water flow in ditches or gutters.

b. Wherever the slope of a gutter is reversed from the traffic way slope, a note to that effect shall appear on the plan.

c. When an inlet adjacent to a curb return is to be set to such an elevation that it serves as the low point along the curb return, and the grades of the intersecting traffic ways are such that a true picture of the top curb grade in the inlet area is not feasible on the profile, then a note shall appear on the plan stating that the top curb grades in the inlet area shall be set in the field to locate the sump at the inlet.

3.1.2.10 Storm Drainage

a. The design engineer shall indicate on the traffic way plans all of the proposed storm drainage system in the right-of-way. The storm drainage shall be shown schematically by a single dashed line, with inlets and drainage structures and direction of flow indicated.

b. If the storm drain system is of minor nature with no other utilities involved, the design engineer may include the storm drain plans on the roadway plans.

3.1.3 Profiles

3.1.3.1 Centerline Grade

a. The Centerline Grade submitted for approval shall be shown and designated "C_L GRADE." On profiles where the grades are warped, or less than 1 percent slope, spot elevations will be required to clarify the proper grade and direction of slope desired by the Engineer.

b. Circles, as shown in the Standard Symbols, shall be used on profile grade lines to designate vertical curve P.V.C.s, P.V.R.C.s, and P.V.T.s and P.I.s of intersecting top curb lines or centerlines. All percents grades shall be shown to two decimal places.

3.1.3.2 Previously Established Top of Curb Grade and Centerline Grade

Where a grade line shown on a drawing is taken from a previously established grade, it shall be designated as "ESTABLISHED TOP OF CURB GRADE" or "ESTABLISHED C_L GRADE." The date established and the design drawing number of such previously established grades shall be noted on the profile. On existing pavement, grades shall be field surveyed.

3.1.3.3 Existing Ground Profiles at Centerlines and Property Lines

The profile of the existing ground along the centerline of a proposed roadway and the profile of the existing ground line along property lines shall be shown by dashed ink lines. The existing ground profiles shall be so labeled, and the date and datum of the field survey shall be indicated.

3.1.3.4 Vertical Curves

A vertical curve shall be shown on profiles as a smooth curve between tangents. The correct templates for given vertical curves will be tangent at the P.V.C. and P.V.T. and

will pass through the computed middle ordinate elevation at the P.I. Computation of the middle ordinate will be required, except where difficult to compute at unusual intersection situations.

3.1.3.5 Top of Curb Grades for Cul-de-Sacs

Top of curb grades for cul-de-sacs shall be shown independently as profiles running linearly around the perimeter of the cul-de-sac including the approach returns. An additional 100 feet overlap on each end of the linear profile shall be shown.

3.1.3.6 Stationing and Elevations

a. Stations of all points of intersection of curb lines and pavement edges shall be determined at right angles to the centerline. Therefore, a face of curb line shall not be extended to intersect a centerline at a skew in order to establish a station.

b. Throughout profiles, elevations shall usually be shown for each 50 feet station with additional elevations every 25 feet throughout horizontal and vertical curves. Stationing shall be in ink at these points on the profile.

c. Elevations on tangents shall be computed; elevations on vertical curves shall be computed. Elevations shall be shown to the hundredths of a foot.

3.1.3.7 Extension of Profiles

a. At any point where a proposed traffic way is an extension of an existing traffic way, the profile of the existing centerline or top curb shall be shown for at least another 200 feet and the heights of the curb face note. All roadway profiles shall be extended a sufficient distance to define clearly the situation, and this distance shall never be less than 200 feet beyond the approval limits requested, except in the case of a profile terminating at a tee intersection. These

profiles shall be independent and shown apart from the proposed top curb profile or profiles.

b. Where profiles must be broken and continued on the same or other sheets, a minimum of 200 feet of profile shall be repeated.

3.1.4 Typical Sections

Typical sections of each type of proposed roadway (i.e. paving width and/or right-of-way width) to be constructed shall be shown once on each set of construction drawings. These sections shall conform with the typical sections shown in the Standard Road and Street Details in the Appendix of this chapter.

3.1.5 Pavement Markings, Signage, Traffic Signals, Street Lights

Plans and details of all pavement markings, signage, street lights, and traffic signals shall be provided. The Developer shall procure and install all signs at the Developer's expense in conformance with the plans prepared by the Developer and approved by the City. Pavement markings shall be installed by the Developer in accordance with the approved plans and this chapter.

3.2 Contract Specifications

Proposed work not covered by the City of Brunswick Standard Specifications for Construction shall be covered in the Frederick County Specifications.

3.3 Estimate of Quantities and Prices

The design engineer shall furnish estimates of all quantities and prices, including a 15% contingency.

3.4 Design Calculations

The design engineer shall submit three copies of design calculations made in connection with the project. The calculations shall be submitted along with the contract drawings.

STREET LIGHTING DESIGN

STREET LIGHTING DESIGN CHAPTER

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As-Built Drawing Statement

STREET LIGHTING DESIGN CHAPTER

1.0 GENERAL

1.1 Responsibility to Provide Facilities

Unless otherwise approved by the City, the Developer of newly developed areas and subdivisions within the City corporation limits shall be required to design and construct street lighting systems in accordance with the City specifications and policies or have the street lighting system designed and constructed by the current power company. The plans shall be reviewed and approved all the City prior to construction. All costs associated with furnishing and installing the street lighting systems including but not limited to: light fixtures; poles; relays; photo eye; foundations; conduit; wiring; control panels; meters and pedestals; and testing will be borne by the Developer. The City will assume ownership of the street light system on streets which the City has accepted and after inspection and testing of the system is complete and the system is functional and approved by the City in all respects. The plans must be designed by and sealed by a Professional Engineer licensed in Maryland who is qualified in the design of electrical street light systems. In the event a conflict exists between the requirements, the more stringent applies.

2.0 MATERIALS

2.1 Lights

Street lights shall be of the type and quality as approved by the City.

2.2 Poles

Poles shall be of the type and quality as approved by the City.

2.3 Wiring

a. Wiring shall be #6 CU, 3 conductor installed in 1 1/2-inch PVC Schedule 40 conduit with a minimum of 24-inches of cover or as approved by the City of Brunswick. Street crossings shall have 30" of cover.

b. Wiring from the fuse holder to fixture shall be 14/3 SEO cable. A /4-inch threaded ground stud shall be welded to the pole base.

c. Conductors shall be fused with fuse holder and BAF 5 amp for each individual fixture.

2.4 Meter/Panel

Meter/Panel enclosure shall be rated for 100 amp minimum.

2.5 Workmanship

All work shall be in accordance with the requirements of the City of Brunswick and the National Electric Code.

3.0 LOCATION

3.1 Spacings

New poles and fixtures will be located between the curb and sidewalk, approximately 12-inches - 15-inches behind the face of curb. The light poles and fixtures shall be located at 100-foot spacing from pole to pole, on alternating sides of the street (staggered) or as approved by the City. A minimum of two (2) light poles and fixtures, staggered across the intersection, shall be required at all collector/collector, or greater, instersections. The final fixture location must be approved by the City.

3.2 Layout Requirements

Fixtures shall be strategically located to provide adequate illumination for all intersections. Adequate shall be defined as providing a minimum of 0.5-foot candles at all locations within the road right-of-way including the intersections of streets or as approved by the City. Conduit shall be provided to the end of each subdivision street constructed by the Developer, with a cap for future extension.

4.0 DESIGN PARAMETERS

4.1 Volt Drop

The maximum allowable voltage drop in any circuit shall be 3 percent. The final

design of all street lighting shall be reviewed and approved by the City of Brunswick.

4.2 Coordination and Approval

The layout, location and source of power must be coordinated with and approved by the City of Brunswick, Allegheny Power Corporation, and the Frederick County Electrical Inspector.

5.0 CONTRACT DRAWINGS AND DOCUMENTS TO BE SUBMITTED TO THE CITY

5.1 Plans

Contract drawings shall be prepared on drawings separate from other utilities. Separate drawings shall be devised for each street or subdivision. The scale of the plans shall be 1-inch = 50-feet or larger. The location of the existing and proposed light fixture shall be clearly identified, with all conduit shown. Street crossing shall be located by centerline stationing of the roadway. All control panels/meter pedestals shall be indicated and each separate circuit numbered for clarity.

5.2 Typical Sections and Details

Plans should include all details of the light poles and fixtures, foundation details and trenching cross sections. Any special design feature shall be shown on the drawing or clearly stated in the general notes.

5.3 Distribution of Final Plans

Provide three (3) copies of the final plans to the Office of Planning and Zoning for use by the City.

5.4 Distribution of As-Built Plans

Provide one (1) copy of the As-Built plans on mylar plan sheets with the statement and Engineer's signature, as shown in the Appendix, and submit to the Office of Planning and Zoning within thirty (30) days of completion and acceptance of the work by the City and on computer GIS diskette in a format approved by the Office of Planning and Zoning.

SEWER SYSTEM DESIGN

SEWER SYSTEM DESIGN CHAPTER
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1.0 SEWER SYSTEMS

1.1 General

This chapter of the Brunswick Design Manual outlines the policies, minimum design criteria and design procedures for the preparation of feasibility reports and construction plans and specifications for City-maintained and on-site sewer system improvements. Developers and/or Design Engineers shall check with the City Office of Planning and Zoning to determine the availability of sewer at the site of a proposed subdivision. In the event a conflict exists between the requirements, the more stringent applies.

1.1.1 City Policy

a. City-Maintained Facilities

The parts of the sewer system which are considered as the property and responsibility of the City of Brunswick are the sewer mains, pump stations, appurtenances and that portion of the sewer services which lie between the City's rights-of-way. The sewer collection and treatment system for Brunswick is maintained by the City of Brunswick.

b. On-Site Facilities

The parts of the sewer services which lie within private property are the responsibility of the owner and are constructed and maintained by the Owner. Construction of private sewer facilities are generally governed by the Frederick County Plumbing code.

c. Requirements for Sewer Service

1. All properties will be connected to the sewer system of Brunswick.

(a) Each building shall be serviced by a separate sewer tap.

(1) Multiple dwelling units such as an apartment dwelling, duplex or residential unit with apartment(s) may be serviced by a single sewer tap.

(b) If an additional building is constructed on an existing lot which has a sewer tap, the new structure must be provided with an additional sewer tap.

(c) If a lot containing more than a single structure is subdivided to provide separate lots for each structure,

the lot(s) without sewer tap(s) must provide these taps as a condition of subdivision.

(d) If a lot containing a single structure is subdivided, each structure erected upon the new subdivided area must procure a sewer tap prior to obtaining a building permit.

1.1.2 Definitions

a. Collector sewer: A sewer constructed within developments which transports sewage to an interceptor sewer.

b. Interceptor sewer: A sewer designed to collect sewage from several developments and transports wastes to a treatment plant.

c. House or building connection (SHC): A sewer which connects a house or other building to a collector sewer. The portion within the public right-of-way is owned and maintained by the City. The portion beyond the right-of-way is owned and maintained by the property owner.

d. Force main: A sewer which conveys sewage from a pumping station to a treatment plant at a higher elevation or to a higher elevation in the sewer from which gravity flow may resume.

e. Manhole: A structure providing access to buried sewer, valve, conduit, etc.

f. Average Daily Flow: The arithmetic sum of the average daily domestic flow plus the average daily commercial flow plus the average daily industrial flow plus any other average daily flow from the service area. The average daily commercial, industrial and other flows shall be based on the period in which these flows are generated.

g. Peaking Flow: The average daily domestic flow peaked in accordance with the curve entitled “Diagram for Converting Average Daily Domestic Flow to Peak Flow” (in the Appendix).

Peak commercial or industrial flow is the average daily commercial or industrial flow peaked in accordance with a factor determined by evaluation of historical data for the commercial or industrial facilities and the periods in which these flows are generated.

The average daily domestic flow, average daily commercial flow, and average daily industrial flow may be peaked individually or combined and then peaked using the curve (in the appendix) as dictated by the evaluation of the sources and periods in which the flows are generated.

Whenever forced flow applies, peak flow shall be equivalent to the pumping rate.

h. Infiltration and Inflow: For design purpose, the upper limit of allowable infiltration and inflow within the areas of the project is 400 gallons per acre per day (gpad). Additional allowance for infiltration and inflow may be made upon verification of evidence or approval of operation data.

i. Design Hydraulic flow: Design Hydraulic flow = Peak Flow + Peak Commercial flow + Peak Industrial Flow + Infiltration and Inflow Allowance.

j. Design Professional: An individual, partnership, or corporation licensed under the laws of the State of Maryland to practice as an engineer, architect, landscape architect, land surveyor or property line surveyor who is preparing contract drawings and documents for a construction project in Brunswick. It shall be the responsibility of the design professional to ensure that the various elements of the project are prepared by appropriately licensed practitioners.

k. Design Engineer: An individual, partnership, or corporation, or an employee thereof, practicing as a licensed engineer in the State of Maryland, who is preparing contract drawings and documents for a construction project in Brunswick. The term "responsible licensed engineer" shall mean Registered Professional Engineer, as authorized to practice under the laws of the State of Maryland.

l. Developer: A person, firm or governmental agency undertaking or proposing the construction of a structure, a project consisting of interrelated structures or other construction, a subdivision plat and/or Site Development Plan and the public and private improvements involved therein, and who has primary financial responsibility for the proposal.

m. Approval: Specific examination and acceptance by a duly authorized representative of the City of Brunswick.

2.0 DESIGN CRITERIA

2.1 General

For the Engineer's guidance, below are listed major elements constituting the design of a Sewer Utility Design project:

a. Pipe size and alignment

b. Profile, with all elevations

c. Pump station site plan, mechanical, electrical, architectural and electrical elevations, plan views and details

d. Property data (lot dimensions, all sides of affected properties, liber/folio

number, owner)

e. Rights-of-way

f. Specifications and notes

g. Cost estimate

2.2 Determination of Design Flows

a. The sizing of major components of the City sewer system such as treatment facilities, are the responsibility of the City and beyond the scope of this manual. The City may require developers to design these facilities as well as finance and construct them. Should this be the case, the City must be consulted for specific design criteria.

b. The design engineer who is responsible for the extensions of sewer mains shall follow the guidelines in this manual for the derivation of design flows. The calculation of sewer flows will usually require extension of the average daily flow for the facility, application of a peaking factor to derive the peak flow, then addition for inflow and infiltration.

c. Generally, the design engineer will be selecting sewer mains of 12-inch diameter and smaller, and often will be required to provide the minimum 8-inch size mains.

2.2.1 Collector Sewers

a. Design Period

A sewage delivery system shall ordinarily be designed to provide for the projected population at ultimate buildout for the contributing drainage area to the facility. Whenever cost-effectiveness permits, the construction may be programmed in stages to accommodate the needs, subject to the approval of the City Commissioners of Brunswick.

b. Existing Development

In developed areas, the basis for flow projection shall be the actual number of single-family homes, apartment units, various types of businesses, etc. present in the drainage area, as determined by field count. An allowance shall be made for undeveloped areas as described below. For each residential dwelling unit, sewage flows of 250 gallons per day for the average daily flow shall be used.

c. Future Development

In small undeveloped areas, the basis for flow projection shall be the maximum number of residential units per acre according to current zoning regulations. This applies to residential or mixed residential/commercial zones. It shall be assumed that each residential unit shall contribute 250 GPD average daily sewage flow. In the case of small undeveloped portions of commercial or industrial zones, design flows shall be based on

the land use consistent with the City of Brunswick Master Plan which would provide the most likely maximum sewage flow. In the absence of specific sewer flows, the design engineer shall use 500 Gallons/Acre/Day

for commercial and light industrial zoned lands for the average daily flow. Heavy Industrial lands shall be assigned 1,000 Gallons/Acre/Day.

In large undeveloped areas, the average daily flow for a given zoning classification shall be as given above.

d. Average Daily Flow

The average daily flow for collector sewers is based on the population and land use inventories and projections described above. Appendices B and C are compilations of average daily flow generation rates for various types of establishments. The flow from each existing establishment shall be based on Appendix B when the number of persons using a facility can be determined or on Appendix C when only the gross area of the facility can be determined. The average daily flow shall be the sum of the flows projected for the existing or ultimate land use of each lot or parcel in the drainage basin. In the case of largely undeveloped drainage basins, the average daily flow shall be based on criteria in 2.2.1.(c).

Average daily flows given in 2.2.1.(c) for industrial facilities are for domestic-type flows only. Flows generated by industrial processes must be determined on a case-by-case basis.

e. Peak Flows

Peak domestic flow is the average daily domestic flow peaked in accordance with the curve entitled “Diagram for Converting Average Daily Domestic flow to Peak Flow” in the Appendix.

Peak commercial or industrial flow is the average daily commercial or industrial flow peaked in accordance with a factor determined by evaluation of historical data for the commercial or industrial facilities and the periods in which these flows are generated. If historic peaking data for these facilities is unavailable, the average daily domestic flow, average daily commercial flow, and average daily industrial flow may be combined and then peaked using the curve in the Appendix.

If it can be established that the peak of the industrial waste flow (and other non-domestic flows) does not occur during peak domestic flow, a percentage (based upon engineer’s field observation and judgment) of the peak industrial waste flow (and other non-domestic flow) shall be added.

f. Infiltration and Inflow

In areas where a sewer is being designed to replace an existing sewer with existing SHC's, a minimum infiltration rate of 400 gallons/acre of drainage basin per day shall be used. A higher rate of infiltration may be justified if there is evidence of poor soil conditions, high groundwater table, or deteriorated SHC's.

In areas where the sewer will serve future development, the infiltration rate should be determined on a case-by-case basis. Factors affecting this determination include the proposed sewer elevation relative to the normal groundwater elevation and the soil types present. The infiltration rate selected for design of new sewers shall be 100 gpd/in-dia/mile.

New clear water connections such as downspouts, catch basins, cellar drains or sump pump drains to sanitary sewers are strictly prohibited from the date of adoption of this ordinance.

g. Design Hydraulic Flow

The design hydraulic flow shall be the sum of the peak flows determined as described in Section 2.2.1 (e), the infiltration rate determined as described in Section 2.2.1 (f), and any industrial flows.

2.2.2 Interceptor Sewers

a. Design Hydraulic Flow

Determination of design hydraulic flows for interceptor sewers shall be generally as outlined for collector sewers. Peak flows generated by ultimate development allowed by the City of Brunswick Master Plan shall be provided for. Interceptors which will carry the flows from a significant number of older collectors may have infiltration rates far in excess of 400 gallons/acre/day. The design engineer may be required by the City to perform flow monitoring in the existing sewer to determine actual flows and remaining capacity if actual flow data is not available by the City. In all cases, the design hydraulic flows shall be approved by the City of Brunswick prior to proceeding with sewer design.

2.3 Hydraulic Criteria

2.3.1 Collector Sewers

a. Size

The size of the sewer shall be sufficient to carry the previously discussed design hydraulic flow with the hydraulic gradient coincident with or slightly below the crown of the pipe. Size shall be determined by the relationship Q = av, where:
Q = quantity of sewage in cfs (design flow)
a = required cross section area of conduit in sq. ft.
v = velocity in feet per second
The minimum size sewer shall be 8-inch inside diameter.

b. Velocity

Velocity shall be determined by the Manning formula:

$$v = \frac{1.486}{n} r^{2/3} s^{1/2}$$

n = coefficient of roughness as indicated in Section 2.4.1.e.5.
s = slope in feet per foot
r = hydraulic radius - area divided by wetted perimeter

Minimum velocities of 2.5 feet per second shall be provided. Minimum velocities shall be determined based upon present average sewage flow.

Where velocities greater than 15 ft/sec are attained, provision shall be made to protect against erosion and displacement by shock. If practical, suitable drop manholes shall be provided to reduce steep slopes so as to limit the velocities in pipes between manholes. When drop manholes are impractical for reduction of velocity, the sewer shall be of ductile iron or other abrasion resistant material as approved by the City of Brunswick.

2.3.2 Interceptor Sewers

a. Size

Interceptor sewers shall be sized to carry the design hydraulic flow when two-thirds full (i.e. the hydraulic grade line will be d/D - 0.67). The minimum size shall be 8 inches inside diameter.

b. Velocity

Velocities in interceptor sewers shall be as presented for collector sewers.

2.4 System Layout Criteria

2.4.1 Collector Sewers

a. Horizontal Layout

1. General

Collector sewers shall be laid on tangents only. All changes of direction and connections to other collector sewers shall be accomplished at manholes. In laying out the sewer, the design engineer shall take into full account such factors as environmental impact, maintenance of traffic, maintenance of existing utility services, constructability, and system maintenance.

2. In New Subdivisions

In new subdivisions, collector sewers shall be located seven feet from the centerline of the street right-of-way, generally on the side of the street toward low ground and on the opposite side of street centerline from the water main. Collector sewers shall be located within the pavement area wherever possible, no less than five feet from the face of the existing or proposed curb. Where it is not feasible for manholes to be located within the pavements, they shall be located wholly within the grass plot or wholly within the grass plot between the curb and sidewalk or wholly within the sidewalk.

3. In Existing Developments with Curbs

In existing developments with curbs, sewer location shall generally be the same as in new subdivisions. The location of other existing and proposed utilities shall be fully considered.

4. In Existing Developments with Pavement and No Curbs

In existing developments without curbs, collector sewers shall generally be located four feet outside of the edge of pavement, except that the sewer shall not be located under a future curb. The location of other existing and proposed utilities shall be fully considered.

5. In Parks and Public Rights-of-Way

Where location of sewer would require removal of or damage to trees within parks or public rights-of-way, design engineers shall obtain approval of the City of Brunswick for sewer alignment and trees to be removed.

6. Easements

All sewer utility easements shall be 30 feet minimum width. No other utilities will be allowed in the sewer utility without the City of Brunswick's permission.

b. Profile Layout

1. Grades

Grades shall be such as to require the least excavation while satisfying minimum and maximum velocity requirements, clearances, and depth requirements discussed hereinafter. All collector sewers shall be on tangent grades with required breaks in grade accomplished at manholes. Minimum slopes shall be as provided for in the Maryland Department of the Environment "Design Guidelines for Sewage Facilities," latest edition.

Terminal sewer collection lines shall be at a minimum 1% grade.

2. Changing Size

When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method is to match the crown of the sewers or to place the 0.8 depth point of both sewers at the same elevation. Generally, sewers should not decrease in size in the downstream direction.

3. Depth

In developed areas, sewer inverts shall be a minimum of 2.5 feet + h below cellar elevations, where h = length of house lateral connection between the sewer and the point of connection to the existing house sewage system, or stack, multiplied by the required house connection slope. For houses without cellars, sewers shall be a minimum of 2.5 feet + h below first floor elevations. In all cases, sewer depth shall be sufficient to meet criteria established for house connection, depth, grade and clearance.

For unimproved lots, maximum sewer depth as controlled by adjacent lots shall generally not exceed 12 feet. Where lots can be expected to be filled to the level of the established grade, depth as regulated by adjacent house connections shall normally not exceed eight feet. Greater depth may be required to clear future storm drains. In all cases, depth shall be sufficient to meet criteria established for house connection depth, grade and clearance.

Sewers at stream crossings shall be constructed with a minimum of three feet of cover between pipe and stream invert. At all stream crossings the design engineer shall consider such items as flotation, stream meandering and scouring and infiltration and shall include such protective measures in the design as encasement, riprap, special pipe, and joints as may be deemed necessary by the City.

4. Gravity Service Not to be Provided

Sewer project plans shall clearly label any improved lots for which gravity service is not to be provided. Any recommendation for not providing gravity service is to be documented, with the reasons therefore, by the A/E to the City for decision. For lots where it is determined that gravity service is not available and the City approves the use of grinder pumps, a note shall be placed on the drawings as follows: "A grinder pump is required for sewer service to this lot."

5. Test Borings

Soils investigations (test borings and/or test pits) may be required by the City as a pre-requisite and approval of the plans.

c. Clearances of Other Utilities

1. Interactive Considerations

In general, existing utilities have prior right to maintain their location. The existence and location of such utilities must be considered when designing new sewers. Clearance shall be measured between outside of pipes. Design engineers shall investigate clearance between sewer and other utilities, both existing and future.

(a) Parallel Installation

A horizontal distance of at least 10 feet shall separate water mains and sewers. The distance shall be measured edge to edge. In cases where a 10-foot separation is not practical, deviation may be allowed on a case-by-case basis subject to City and State approval if supported by data from the design engineer. Such deviation may allow closer installation, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.

(b) Crossings

Where water mains and sanitary sewers, building drains or storm drains must cross, there shall be a vertical separation of 18 inches between the bottom of the water main and the top of the sanitary sewer, building or storm drain. This vertical separation must be maintained horizontally for a distance of 10 feet. The 10-foot distance is to be measured as a perpendicular distance from the sewer, building or storm drain to the water line.

(c) Exceptions

When it is impossible to obtain the proper horizontal or vertical separation as stipulated above, both the water and sewer lines shall be constructed of ductile iron with mechanical joints. Other types of pipe and joints with equal or greater integrity may be used at the discretion of the City. Where a water main must cross under a sewer, additional protection of the water main shall be provided. The City shall be consulted to discuss the use of double casing or concrete encasement of the sewer and/or water main. (See details in Appendix.)

2. Separation of Utilities and Sewer Manholes

No utilities shall pass through any part of a sewer manhole.

3. Clearances at Other Utilities

Sewers shall have a minimum of 12 inches clearance from drains, gas mains, and other unspecified utilities. If 12 inches cannot be maintained at crossings, provide encasement of sewer for the width of 10 feet on each side of the crossing.

d. Appurtenances

1. Manholes

Manhole details are shown in the City's Standard Details. The designer shall use these standards as required to meet the design situation and shall designate the type of each manhole on the contract drawings. Maximum spacing for manholes shall be 400 feet. Line manholes shall generally be used at all changes of pipe size, grade, alignment, or connections of two or more sewers. A minimum drop of 0.10' shall be used at line manholes. Generally, a drop pipe should be provided where the difference between the crown of the effluent sewer and the invert of the influent sewer exceeds 2 feet, subject to the limitations of standard fittings. Concrete encasement should be provided to support the drop pipe.

The minimum diameter of manholes shall be 4.0 feet. Larger diameters are preferable. The size of manhole entrance shall be 2.0 feet or larger in diameter. The thickness of manhole walls shall not be less than 8 inches for the upper 12 feet of depth and shall increase 4 inches for each additional 12 feet of depth. The flow channel through manholes shall be made to slope and conform in shape to the sewers.

e. Structural Considerations

1. Soil Conditions - Foundations

Where extremely poor soil conditions, such as running sand, material with high organic content, etc. are anticipated, design engineers shall secure soil samples and discuss the analysis of the samples with the City. In all cases, a proper foundation shall be provided for pipes.

2. Grades - Anchors

Sewers designed on slope of 20 percent or greater shall have anchorages as follows (consult the City for details):

20% - 34%	36' center to center (max.)
35% - 50%	24' center to center (max.)
50% +	16' center to center (max.)

3. Underdrains

Where there is evidence of spring heads or a high groundwater table in the area of the proposed sewer, underdrain shall be provided. Underdrains shall be extra strength concrete sewer pipe (CSPX), or pipes of equal strength, and need to be shown on the drawings.

4. Depth and Loading

Minimum and maximum permissible depths and loadings for pipes of the various types and classes shall be in accordance with manufacturer's recommendations and bedding requirements. Manufacturer's data shall be submitted as part of the Engineering report. Ductile iron pipe shall be used where depth is less than 4 feet or greater than 20 feet. PVC pipe, SDR 35 may be used for depths of 4 feet to 10 feet. PVC pipe SDR 26 may be used for depths of 10 feet - 20 feet.

5. Pipeline Materials

The materials allowed for sewer construction, together with their Mannings 'n' are listed below. The choice of materials is at the engineer's discretion, subject to the City's approval, provided allowable maximum velocities and structural loading criteria are met. Fittings that are necessary for wye branches, etc. shall be approved by the City. Only one type and description of pipe shall be used between two manholes.

Pipe Type (abbreviation)	'n' Coefficient	Range of Diameters
Ductile Iron (DIP)	0.013	6" & larger
Reinforced Concrete (RCP)	0.013	12" & larger
Concrete Sewer Pipe (Extra Strength) (CSPX)	0.013	6" & larger
Polyvinyl Chloride (PVC)	0.010	6" & larger
Reinforced Concrete Cylinder (RCCP)	0.013	16" & larger

Design engineers shall consider the effect of industrial waste on sewer pipe. Several industrial wastes, such as sulfuric acid, are known to cause deterioration of concrete pipe. Wherever harmful wastes cannot be prohibited from sewers or diluted prior to entry, the use of liner plates or other pipe protection shall be required for concrete pipe. In addition to consideration of industrial wastes, the design engineer shall also consider other local conditions, such as septicity, exceptionally heavy loadings and abrasion due to high flow velocities, in selecting pipe materials.

Use Ductile Iron Pipe (DIP) under the following conditions:
- Where sewer depths are 4 feet or less.
- Where sewer depths exceed 20 feet.
- In interceptor sewer applications where maintenance is perceived to be a problem

- Creek or stream crossing (alternative to DIP is concrete encasement of PVC 10 feet either side of stream bank).
- Off road areas where maintenance is not achievable or where individual homeowners may be severely affected by repair efforts

f. Venting

The design engineer shall indicate method of proposed ventilation of gravity sewers.

g. Testing

Sewer mains shall be tested in accordance with the City's specifications, using air testing procedures. All manholes are to be vacuum tested.

h. Jacking and Tunneling

Where mains are being designed to cross railroads, state highways or other roads on which service cannot be interrupted, the sewer main shall be installed in a sleeve, tunneled or jacked under the road. The sleeve size and material and the method of tunneling or jacking shall be approved by the owner of the road or the railroad being crossed.

The sleeve diameter shall be sufficient to permit the proper positioning of the sewer main within the sleeve. The annular void between the main the sleeve shall be completely filled with grout, sand or as shown in the Standard Details.

2.4.2 Interceptor Sewers

a. Horizontal Layout

Interceptor sewers generally follow streams or the valley of a drainage area. They shall be located so as to best serve the drainage area. Special caution is required to insure the proper location of manholes for future connection of collecting sewers and ease of maintenance by the City.

Sewers shall be laid with straight horizontal alignment between manholes. Where the sewer is planned in a City road right-of-way or a park, layout shall be as described for collector sewers.

b. Profile Layout

Grade requirements shall generally be as described for collector sewers. The depth of interceptor sewers is not directly controlled by lot and house elevations. The depth of interceptor sewers shall be sufficient to allow connection of all existing and foreseeable

future collector sewers within the drainage basin served. In general, sewer elevation should be three feet lower than the stream bed and have six feet of cover where possible.

Where interceptor sewers cross streams, the requirements of Section 2.4.1.e.5. shall be met, except that concrete encasement shall be required in all cases and will extend 20 feet each way from the stream bank.

c. Clearances at Other Utilities

The requirements for horizontal and vertical clearances between interceptor sewers and other utilities shall be the same as those for collector sewers.

d. Appurtenances

Manhole requirements for interceptor sewers shall be the same as those for collector sewers, with the following modifications. Manholes will be required where collector sewers join the interceptor. Precast concrete manholes constructed shall meet the standard ASTM C478 criteria.

e. Structural Considerations

Structural considerations shall be the same as for collector sewers.

2.5 Grinder Pumps/Pressure Sewer Systems

2.5.1 Purpose

The purpose of this section is to provide a Policy and Procedural Guide for Alternate Wastewater Systems. The following is for Grinder Pump/Pressure Sewer Systems to serve existing or proposed development.

2.5.2 Policy

a. Determination of Use

Grinder Pumps/Pressure Sewer Systems will not be considered as a method of providing sewer service that could otherwise be furnished by conventional gravity system (including pumping stations) at a reasonable cost. A final determination on the use of grinder pumps will be made by the City of Brunswick. An economic analysis, based on a total present worth, must be submitted by the developer or design engineer for use by the City in making the final decision.

b. Temporary Use

Grinder Pumps/Pressure Sewer Systems are not normally to be used on an interim or temporary basis in anticipation of conventional facilities installed in the future.

c. Ownership and Maintenance

The property owner will own and maintain all grinder pumps, regardless if installed by the City, Developer, or by property owner. The property owner will be responsible for electrical costs to operate the pumping units.

d. The manufacturer of grinder pumps shall be approved by the City. Low pressure sewer mains shall be sized according to the design manual offered by the grinder pump manufacturer. The City shall be consulted on specific design and construction standards for the grinder pump and low pressure sewer mains, if approved for use by the City of Brunswick.

2.6 Sewer House Connections

2.6.1 Location

The City-owned portion of house connections shall be built to the property line for all lots within proposed developments. All adjacent improved lots which are not a part of the proposed development but which may be served by the sewer line shall be shown on the contract drawings. Connections for these lots shall be shown, where and as directed by the City. Where sewers are at sufficient depth to require drop house connections, design engineers shall discuss house connection location with the City. No twin sewer house connections shall be allowed. The City will not permit extension of sewer connection beyond the corporate boundaries with the possible exception to serve public facilities, such as parks, on a case-by-case basis.

2.6.2 Size

Connections to large buildings such as apartments or commercial/
industrial properties shall be designed and sized in accordance with the criteria previously presented for collector sewers. The minimum connection size for home and smaller buildings shall be four inches diameter.

2.6.3 Materials

House and building connections shall comply with ASTM 3034, SDR 35 PVC; ASTM F789, T-1 PVC; or AWWA C151 DIP.

2.6.4 Appurtenances

Cleanouts shall be provided on all building connections at the property line. Cleanouts shall be as shown in the Standard Details. All cleanouts must be installed vertically to be accepted by the City. This cleanout is to be used on all systems regardless of the air test requirements. No solvent weld joints will be allowed.

2.6.5 Grades

House and building connections shall be two percent minimum grade, unless otherwise approved by the City. The maximum grade shall be five percent. A one percent minimum grade may be allowed by the City with adequate justification from the Developer and approved by the City. Minimum cover at property line shall be four feet. Where storm drains have not been designed or have not been installed, house connections shall have a minimum cover within the street right-of-way of 6.5 feet.

2.6.5 Clearance

a. Crossing Water Main

Clearance shall be measured between outside of pipes. Sewer house and building connections crossing water mains (existing or future) shall be a minimum of 12 inches clear below water mains. Sewer house and building connections crossing above water mains shall be encased in concrete (see detail in Appendix)10 feet each side of water main or constructed of ductile iron pipe (push-on or mechanical joints).

b. Parallel to Water House Service

Sewer house and building connections shall ordinarily be not less than 10 feet horizontally from water house service and a minimum of one foot clear below water house services. If City approves placing sewer house or building connections above water house service, such connection shall be ductile iron pipe (push-on joints or mechanical joints).

c. Crossing Storm Drains and Other Utilities

Sewer house and building connections crossing storm drains and other utilities (existing or future) shall have a minimum clearance of six inches from these utilities.

2.6.7 Structural Considerations

Minimum and maximum permissible depths shall be in accordance with those of collector sewers.

Where poor soil has required the use of ductile iron pipe collector sewers or ductile iron pipe (DIP), house and building connections of the same material shall be used.

2.7 Repaving of Roads

2.7.1 General

a. All City construction contract specifications shall include a “patch-pave” requirement as follows:

Properly compacted borrow aggregate backfill shall be placed and compacted from 3 inches below the pipe to the bituminous pavement subgrade. The pavement replacement shall consist of a base course of asphaltic concrete of at least a thickness equivalent to the original pavement section, the original wearing course cut back two feet on all edges of the excavation and a new asphaltic concrete wearing course of at least a thickness equivalent to the original wearing course. Other road pavement sections will receive similar treatment. The base course shall be a minimum of 4 inches, and the wearing course shall be a minimum of 2 inches.

b. Patch-paving as outlined above is to be accomplished whether the roadway is to be re-paved or not.

c. House connection installations will require the same specifications for patch-paving.

d. All paving/re-paving work will be accomplished in accordance with the City Road Specifications or Design Manual. A 'road cut' permit must be obtained from the City when excavating within an existing City maintained roadway.

e. Pavement patch on State or County roads shall be in accordance with requirements of the applicable agency.

2.7.2 Timing of Patch-paving and/or Re-paving

a. Specifications will provide that patch-paving shall be accomplished immediately after backfilling and achieving specified compaction for connection and small extension contracts and at no greater than seven (7) calendar day intervals for larger projects. Temporary "cold patch" shall be required for patches not immediately patch-paved. The City must be consulted if immediate patch-paving cannot be accomplished. Cold patching must be maintained by the developer to the City's satisfaction. The placement of steel plates over trenching may be approved by the City on a case-by-case basis.

b. Re-paving shall be specified to be accomplished in one continuous effort to best assure economy and consistency of quality work.

2.7.3 Traffic Control

All water utility construction projects shall have an approved traffic control plan, using requirements of the Manual on Uniform Traffic Control Devices.

3.0 SEWAGE PUMPING STATIONS

3.1 General

These design standards are intended to facilitate engineering of sewage pumping stations to meet the service needs of users and the operational responsibilities of the City. The sewage pumping station design standards include criteria and design guidelines. This section includes the criteria and guidelines for designing sewage pumping stations within the limits of applicability for these design standards.

The design standards generally apply to sewage pumping stations up to 3.0 MGD capacity. Not included within the group of sewage pumping stations covered by this section are several special applications: individual user pumping installation, lift stations, and sewage pumping stations with capacity in excess of 3.0 MGD.

The design engineer shall check with the City to determine the applicability of these design standards to planned sewage pumping stations. It is the responsibility of the design engineer for blending all applicable criteria and guidelines for sewage pumping stations incorporated into the City of Brunswick Sewage System.

3.2. Design

3.2.1 Design Criteria

Sewage pumping stations must satisfy the criteria relating to regulations of agencies having jurisdiction, design flow rate, hydraulic conditions and site characteristics.

1. Applicable Regulations

Sewage pumping stations shall conform to the Design Guidelines for Sewerage Facilities, 1978 edition or latest as published by the Department of the Environment, State of Maryland. City of Brunswick Office of Planning and Zoning land use regulations shall be considered in the selection and development of sewage pumping station sites. Buildings shall comply with BOCA requirements and permitting requirements of the City of Brunswick. Other regulations governing facilities and construction shall be adhered to. These will include the Occupational Safety and Health Administration, National Electric Code, Frederick County Plumbing Code and others.

2. Flow

The design flow for sewage pumping stations shall consider existing and project peak flow rates and sewage composition.

a. Planning Period

Sewage pumping station discharge flow rates shall, at a minimum, accommodate a 20-year planning horizon. In circumstances where the status of a planning pumping station is interim, the planning period for establishing flow rate may be shorter. For all but interim pumping

stations, consideration shall be given to future upgrading flexibility necessary to accommodate flows beyond the normal 20-year planning horizon. This is especially important for larger (more than 200 GPM) sewage pumping stations.

b. Existing and Projected Flow Rates

Sewage pumping stations shall be designed to pump the flow for existing and future users. In developed areas population shall be determined by house count and non-domestic user inventory, with allowances made for remaining undeveloped tributary areas. Population densities and per capita flows shall be as established by Facility Plans or, in their absence, in agreement with the Water and Sewer Master Plan or instruction of the City.

c. Composition

Sewage composition can vary widely, depending upon the proportion of design flow generated by non-domestic users. Non-domestic user sewage composition shall be investigated. Adequate consideration and necessary provisions shall be taken to ensure that sewage pumping station equipment and materials are suitable for the anticipated composition of sewage. Consultation with the City is required in the event that sewage composition affects standard material and equipment requirements.

3. Hydraulics

A complete analysis of each sewage pumping station is required. An investigation and analysis of the sewage pumping station and force main system to consider features of configuration and operation shall be conducted. Sewage pumping stations shall be designed to operate at the appropriate discharge head and flow rate.

a. Pump/System Curve

System curve characteristics shall be determined by the Williams-Hazen formula for piping headlosses. The pump/system curve shall be shown on the drawings.

b. Water Hammer

The potential impact of water hammer shall be evaluated. If the combined effects of static head and water hammer do not exceed the weakest piping system component working pressure, no special provisions need to be included to control water hammer. Where the maximum water hammer pressure exceeds the weakest piping system component working pressure, strengthen those elements affected, or select an appropriate device to control water hammer. The decision to strengthen

piping system components instead of utilizing a water hammer control device shall be based upon life cycle cost economic comparison.

4. Siting

Sewage pumping station site selection is dependent on a number of factors. Topography, access, availability of power supply, floodplain, land use, esthetic concern, overflow potential and impact to the environment shall collectively be considered in the process of site selection.

a. Topography

Sewers tributary to sewage pumping stations commonly dominate site selection. Adjacent drainage areas potentially served by the sewage pumping station must also be considered. Sewage pumping station site selection shall also be compatible with suitable access and soil capability with respect to landgrading in conjunction with site development.

b. Access

All sewage pumping stations shall be sited to permit access by all weather surface roads. Access road and parking or working areas within the pump station must be paved with bituminous or concrete pavement. The depth of pavement shall be dictated by the City of Brunswick.

c. Floodplain

Sewage pumping stations shall be sited to remain operational and permit access during a 100-year return frequency flood.

d. Land Use

Sewage pumping station sites should be selected to occupy vacant land. In new subdivisions the sewage pumping station site shall occupy an area at least equivalent in size to the minimum allowable lot size. In existing subdivisions site size shall meet the minimum allowable lot size if possible. Pump station sites wherever possible must conform to land use regulations such as building restriction lines. Special exceptions and variances may be required.

e. Esthetics

Natural screening and remoteness of site should be provided by site selection wherever possible. Where pump stations are sited in proximity to developed areas, predominate wind direction for potential odor dispersion and building aspect for generator exhaust and ventilation fan noises shall be considered.

f. Overflow

Sewage overflow at sewage pumping stations is not permitted. Sewage pumping station sites shall be selected to permit site development which will preclude on-site overflows.

3.2.2. Guidelines

To the extent practical, sewage pumping station designs shall conform to the guidelines given. The guidelines shall be applied to design situations in a careful and thoughtful fashion.

1. Selection of Sewage Pumping Station Type

The type of sewage pumping station required by the City will be governed by station capacity in terms of flow rate and horsepower. Sewage pumping stations will be custom built-in-place wet well/dry well type, engineered package wet well/dry well type, engineered package submersible type, or engineered package wet well mounted suction lift type subject to the limitations set forth.

a. Custom Built-In-Place Wet Well/Dry Well Sewage Pumping Station

This type of sewage pumping station will be designed for installation with design flows above 1.5 MGD. Custom built-in-place stations shall be engineered to meet the requirements of these guidelines.

b. Package Sewage Pumping Station

This type of sewage pumping station will be utilized for design flows of 1.5 MGD and less. Depending upon flow rate and motor horsepower, the packaged pump stations will be wet well/dry well configuration, submersible configuration, or wet well mounted suction lift station. Packaged sewage pumping stations shall be engineered to meet the requirements of these guidelines.

(1) Submersible

Submersible sewage pumps with guide rail and pump discharge elbow assemblies installed in the wet well shall be used for small sewage pumping stations. Submersible type sewage pumping stations shall be used at locations where design flow does not exceed 200 GPM and motor horsepower is 10 or less. If either motor horsepower or design flow limitations for

submersible type sewage pumping stations are exceeded, other types shall be used.

(2) Dry Well/Wet Well

Dry Well/wet well sewage pumping stations may be used where flows are in excess of 200 GPM or where a submersible station would require a motor greater than 10 horsepower.

(3) Wet Well Mounted Suction Lift Station

This type may be used where flows are in excess of 200 GPM or where a submersible station would require a motor greater than 10 horsepower. Suction lift stations generally are only to be used where the depth of wet well is less than 15 feet.

c. Other Configurations

In special circumstances due to extraordinary sewage composition, rehabilitation of an existing installation or other reasons, the City shall be consulted to determine the acceptability of other configurations before sewage pumping station design begins.

2. Site Improvements

Sewage pump stations must be developed with the necessary improvements to ensure adequate and reasonable access, security, drainage and maintainability.

a. Access Road

All sewage pumping stations must provide complete vehicular access.

(1) Duty and Section

Access roads should be designed to accommodate all types of vehicles at low speeds from passenger automobiles up to large tanker trucks. An all weather surface with cross section design adequate to support the vehicular loads anticipated should be designed for local soil conditions. Access roads shall be a minimum 12 foot wide single lane with 2 percent cross slope to provide surface drainage. Two foot wide shoulders on each side of the road surface shall be included with a cross slope of 6 percent. Swales, ditches and culverts as necessary shall be provided to ensure adequate storm drainage for a 10-year return frequency rainfall event. Grading and slope stabilization in conjunction with access road design

shall be compatible with local soil conditions. In no case shall the depth of bituminous pavement or concrete be less than 6 inches.

(2) Geometry

Horizontal access road geometry shall permit vehicular movement such that vehicle tires can remain on road and shoulders at all curves. Turning flares shall be provided at the intersection with traveled roads. Vertical access road geometry shall provide smooth grade transitions and adequate site angles at intersections with traveled roads. Access road grades should be limited to 8 percent, but in no case may exceed 12 percent. Access roads shall satisfy all horizontal and vertical geometry requirements for vehicles in size up to large unit trucks.

(3) Security

Access roads longer than 75 feet in length shall include a padlocked entrance chain between pipe bollards across the access road. The chain and pipe bollards shall be set back a minimum of 5 feet from the right-of-way line. Consideration may be given to access road entrance chain and pipe bollards for access roads less than 75 feet in length.

b. Sewage Pumping Stations

All sewage pumping station sites shall be improved with paved surfaces, security fences, site lighting and screening. Certain locations and attendant conditions may require other improvements which may consist of storm drainage systems or more extensive security provisions.

(1) Perimeter Fence

All sewage pumping stations must have a 6 foot high chain link fence surrounding the parking area, building, wet well, dry well and vaults. In areas particularly subject to vandalism, higher fences and electronic security systems should be considered on a case-by-case basis. Full width fence gates, up to fourteen feet wide, with padlocked astrigal shall be located to suit entry and exit of the pump station site. All exposed fencing materials shall be black vinyl coated.

(2) Paving and Other Surfaces

Sufficient bituminous paved surfaces, within the sewage pumping station perimeter fence, shall be provided to enable maneuvering and turning of vehicles in size up to unit trucks. The paving section composition shall consist of band SN surface course, an underlying band BF and a CR-6 crushed stone base course, all of a composite thickness necessary to support all anticipated wheel loads in consideration of local soil

conditions. The remaining surfaces inside the perimeter fence not occupied by structures shall be covered with a compacted course of washed SRC-2A stone of thickness equal to bituminous concrete site paving and underlain by a CR-6 crushed stone base course of thickness equivalent to the paved surface base course.

(3) Grading

Sewage pumping station grades for paved areas shall prevent local ponding, provide positive drainage away from structures and generally be limited to no greater than 4 percent slopes. Stone surfaces around paved areas shall provide proper site drainage at slopes 10 percent or less. Landgrading outside of the sewage pump station perimeter fence shall not exceed 3 to 1 slopes, and 4 to 1 slope maximums are desirable. Lesser slopes wherever possible are preferred. Site grading design shall be compatible with slope stability for soils encountered. Slope stabilization shall be appropriate for the degree of slope and soil conditions.

(4) Landscaping

All sewage station sites shall be screened as appropriate for surrounding development.

Landscaping materials should be aesthetically pleasing and require minimal maintenance.

(5) Lighting

Exterior lights shall be wall mounted on the pump station building, high pressure sodium type controlled by a photocell.

c. Structures

All structures shall be protected from 100-year return frequency floods. Structure foundation design shall be based upon geotechnical evaluation of underlying bearing stratum. The design engineer shall include the geotechnical report and boring report in the project specifications.

(1) Building

Sewage pumping station electrical, control and standby power systems are to be housed in an at-grade brick and block building with wood roof trusses and shingles. Prefabricated concrete buildings may be used only if approved by the City. The building shall be sized to afford reasonable access to and removal of all components housed within. Details of construction shall follow the architectural, structural, mechanical and electrical standard design. All buildings shall be designed to comply with

BOCA Building Code and comply with the Brunswick Floodplain Ordinance.

The control room shall be heated with an electric unit heater to automatically maintain 68º F during the winter. The control room shall be ventilated to eliminate heat buildup during the summer. An exhaust fan shall be provided and controlled by a thermostat.

(2) Pumping Station

Sewage pumping equipment will be located in a below grade concrete structure of the type indicated for the capacity planned. The pumping station concrete structure(s) shall extend at least 6 inches above finished grade.

(3) Vaults

Precast concrete vaults for emergency station bypass pumping connections and valves shall be provided for package sewage pumping stations. Valve vaults for submersible sewage pumping stations shall be segmented and contain emergency connection couplings and valves in one compartment and all pump discharge check valves, isolation valves, gauges and flushing connection control valve in a separate compartment. Submersible sewage pumping station vaults shall extend 6 inches above grade and shall have hatches and ladders with spring-loaded extension poles to access valves and emergency connection couplings. Vault dewatering when required will be accomplished with portable pumps. Vaults normally will be surrounded with bituminous concrete paving.

3. Sewage Pumping Station

Sewage pumping station structures, equipment systems, piping, controls and accessory systems must be engineered according to these guidelines to form a cohesive design integrating the intended service and operational characteristics stipulated. To fulfill the intent of these guidelines, the designer must exercise judgment to use the special knowledge relating to project site characteristics and conditions of service (head, flow, force main, etc.) particular to the sewage pumping station design under development.

a. Wet Well

Wet wells shall be as hazard free as possible and of corrosion resistant materials.

(1) Structure

Sewage pumping station wet wells shall be constructed of reinforced concrete. Package sewage pump station wet wells shall have cast-in-place

base slabs and top slabs with precast riser sections. Custom built-in-place sewage pump station wet wells shall be compartmented and constructed entirely of cast-in-place reinforced concrete. The structural design of cast-in-place concrete is the responsibility of the design engineer. Wet wells shall have an interior epoxy paint finish and exterior elastomeric membrane water-proofing in accordance with Technical specifications. Wet wells shall be adequately designed to prevent floatation. Wet well size and depth shall be as required to accommodate the influent sewer, pump suction submergence as recommended by Hydraulic Institute Standards or in the case of submersible pumps complete pump submergence. The required working volume and preferred intervals between sewer and control elevations shall be determined as follows:

(a) Working Volume (in Gal.) = $\frac{TQ}{4}$

Where T = minimum time between motor starts or 7 minutes, whichever is greater

Q = discharge rate of one pump in operation in GPM

Working Volume = lead pump on - lead pump off

(b) Minimum inside width - 6 feet

(c) Minimum elevation difference between influent sewer invert and high water alarm - 6 inches

(d) Minimum elevation difference between control elevations - 6 inches

(2) Access

Package pump station wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36 by 30 inches minimum size and as large as necessary to allow removal of equipment from the wet well. An aluminum ladder with extendible springloaded aluminum safety poles at the top shall be provided to permit safe entry. Structures 20 feet in height or more shall be equipped with removable intermediate landings as required to obtain less than 20 foot intervals. The ladder landing on the wet well floor shall be flat. Custom built-in-place wet well personnel access shall be stairs, minimum of 36 inches wide. Provisions should be made for wet well access openings large enough for equipment removal.

(3) Wet Well Work Platform

Package pump station wet wells shall have an intermediate platform completely covering the wet well. The work platform shall be constructed of aluminum grating sections and grating supports of structural aluminum shapes fastened to the wall. Custom built-in-place pump station wet wells shall have an aluminum perimeter platform with handrail over the wet well and screening channel. Seven feet minimum of headroom over work platforms is desirable. Care shall be taken to locate removable grating sections consistent with equipment placement and removal requirements. All fixed grating shall be bolted down as detailed. All fasteners to be stainless steel.

(4) Debris Removal

All sewage pumping stations will have bar racks for debris removal. Package sewage pumping stations will have manually cleaned static bar racks attached to the wet well wall and work platform. Static bar racks shall be of welded aluminum and stainless steel construction with a welded aluminum debris basket to accept bar rack strippings. The debris basket shall be removable and should be easily hoisted through the open access hatch above. Custom built-in-place sewage pump stations shall have a special debris screening channel and bypass channel upstream of the segmented wet well. Aluminum stop gate guides shall be cast into the channel walls for insertion of flow isolating aluminum stop gates. The debris screening channel shall be fitted with a mechanical bar rack of the front cleaning design with no moving parts below the sewage in the channel. Strippings from the mechanical bar rack shall be shredded or ground and returned to the channel without need for further handling at the sewage pumping station. Mechanical bar rack sizing shall be based upon maximum through bar velocity of 3 feet per second. Maximum clear opening between bars shall be 1-1/4 inches for all bar racks. Bar rack headloss shall not cause any reduction in influent sewer flow velocity.

(5) Invert Slope

Wet wells shall have sloping sides to form a hopper at the bottom of the wet well. Package sewage pumping stations shall have grout fill slopes of 1 horizontal to 1.75 vertical. Custom built-in-place sewage pumping station wet wells shall have side slopes of 1 horizontal to 1 vertical if possible. The flat portion of the wet well floor shall be sufficient in area to accommodate equipment mounting, ladder landings and recommended pump suction hydraulic pump suction hydraulic conditions as outlined by Hydraulic Institute standards.

(6) Level Control

Wet well liquid levels are controlled by a solid state submersible level transducer with D152 controller from Consolidated Electric with back up

float switches. Other types of controllers may be required, depending on the complexity and control logic the City requires. These systems within the wet well shall be located to minimize the turbulent influence of flow into the wet well on the control of liquid level. Float staffs shall be readily removable from the wet well work platform.

(7) Odor Control

Odor control method selection will be offered by the design engineer for approval by the City. The City reserves the right to require a different method if deemed appropriate. It should be assumed that a pump station with a greater than two-hour force main detention time will produce both H_2S and NMOC levels greater than 5 ppm and require odor control.

(8) Lighting

Wet wells shall be provided with wall mounted explosion proof incandescent light fixtures with guard and globe. One fixture shall be installed above the grating and one fixture below the grating. A waterproof switch shall be installed to operate the lights.

(9) Ventilation

Wet wells shall be provided with a separate ventilating system and shall be sized to provide a minimum of 30 complete air changes per hour. In addition to manual control, time clock operation of fans shall be provided to allow a minimum of 2 complete air changes per hour. Ventilation shall be accomplished by the introduction of fresh air into the wet well under positive pressure. If the fan is installed outdoors, the fan housing shall be weatherproof construction. The entrance hatch to the wet well shall be provided with a switch to energize the fan whenever the hatch is open.

(10) Dewatering

Package sewage pumping station wet well dewatering shall be accomplished by means of a portable submersible pump.
Suitable grating openings and wet well floor space shall be provided for this purpose. Custom built-in-place sewage pumping station wet wells shall have individual valued drains to a common station drain sump. The drain sump shall be duplex solids handling pumps with valved discharge piping to at least two of the wet well compartments.

b. Dry Wells

Below grade dry wells shall be designed to provide suitable environments for operating and maintaining pumping equipment and piping systems. Configuration

of dry well components shall promote safe access and adequate space for equipment and valve maintenance. Hazards must be avoided.

(1) Structure

Sewage pumping station dry wells shall be constructed of reinforced concrete. Package sewage pump station dry wells shall have segmented precast concrete base, riser, access tube and top slab sections as necessary on a cast-in-place structural concrete base slab foundation. Custom built-in-place sewage pump station dry wells shall be constructed integral with the wet well and above grade building structures. The structural design of all cast-in-place concrete is the responsibility of the design engineer. Dry well exteriors shall be waterproofed with elastomeric membrance as specified in the Technical Specifications. Dry well interiors shall have a smooth, easy to clean special coating finish as specified in the Technical Specifications. Dry well depth and size shall be adequate to provide proper wet well suction and spaces for maintenance and removal of all equipment.

(2) Access

Package pump station dry well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch and precast access tube riser shall be of sufficient size to permit the removal of an assembled sewage pump or any other station component, if larger. Minimum hatch size shall be 36 inches by 30 inches. An aluminum ladder with extendible spring loaded safety poles at the top shall be provided to permit safe precast concrete dry well entry. Structures 20 feet or more in height shall be equipped with removable intermediate landings as required to obtain less than 20 foot intervals. The ladder landing area shall be sufficiently clear to permit easy ladder use and equipment removal. Custom built-in-place dry well personnel access shall be stairs, minimum of 36 inches wide. Additional grating, plate or concrete covered access openings shall be provided directly above each pump.

(3) Lighting

Precast concrete dry wells shall have wall mounted vapor-proof incandescent lights. Cast-in-place concrete dry wells shall have lighting systems specifically designed to provide illumination best suited for the dry well layout which may include suspended, wall, or ceiling mounted; incandescent, fluorescent, or other types of fixtures. Dry well lighting shall be at levels adequate for routine service inspections and maintenance activities. Portable supplemental lighting will be utilized for unusual or non-routine maintenance activities.

(4) Ventilation

Dry wells shall be provided with a separate ventilating system and shall be sized to provide 10 air changes per hour. In addition to manual control, time clock operation of the ventilating fans shall be provided. Ventilation shall be accomplished by the introduction of fresh air into the dry well under positive pressure. Precast dry well ventilating fans shall be continuously energized whenever the access hatch is open.

(5) Heating

Thermostatically controlled electric unit heaters shall be provided to maintain a minimum of 55 degrees.

(6) Humidity Control

Precast dry wells shall have small wall mounted dehumidifier units piped to drain in the dry well sump. Cast-in-place concrete concrete dry well dehumidifiers shall be considered on a case-by-case basis.

(7) Sump Pump

Precast dry wells shall have a simplex sump pump with minimum discharge capability as specified in the Technical Specifications. Cast-in-place concrete dry wells shall have duplex submersible sump pumps located in a common station drain sump. Duplex sump pumps shall each have capacity to handle anticipated maximum station drain system flow. Sump pumps shall discharge into the wet well. All dry wells shall be provided with a float switch emergency alarm system to protect the dry well from flooding in the event of sump pump failure. Each sump pump shall have dual check valves installed on the discharge piping to protect the dry well from siphoning from the wet well.

c. Pumping and Piping System

All sewage pumping stations shall have multiple pumping units. Sewage pumping stations shall be capable of delivering the design flow rate with the largest pumping unit of service. Sewage pumping station design shall permit individual pump maintenance while maintaining the station in operation. Suction and discharge piping must be supported rigidly at or near the pump connections.

(1) Piping

The minimum size for sewage piping (except surge relief valve discharge piping) shall be 4 inch. Pump suction piping velocity should be within the range of 2-1/2 to 5 feet per second. Pump discharge piping shall be sized to provide velocities in the range of 2-1/2 to 10 feet per second. Pump suctions should have free and smooth unobstructed bellmouth openings in

the wet well. Individual pump suctions are required for each pump. Flooded pump suction is desired under all normal conditions of operation. Pump suction piping design and installation shall not permit the accumulation of air in the suction piping or induce excessive turbulence in the pump suction area. Long radius suction piping bends to be used whenever possible. Packaged sewage pumping stations shall have adequate piping and fittings to permit station bypass pumping with portable above grade pumps. All sewage pumps shall be provided with casing drains with ball valve shut-offs installed either on the pump suction elbow or on the suction line between the pump and suction isolation valve. Take-off nipples shall be schedule 80 stainless steel. Pipe nipples must not be installed in a tapped hole in piping. Use either a welded-on thread-o-let connection or service saddle.

(2) Valves

Each sewage pump shall have isolation valves to permit the removal or maintenance of the pumps without affecting the operation of remaining pumps. Isolation valves 10 inches and smaller shall be non-lubricated plug valves. 4 to 6 inch plug valves shall be quarter turn to open. Larger plug valves shall have geared operators with handwheels. Isolation valves larger than 10 inches shall be solid wedge, non-rising stem type gate valves with handwheel operators. Plug valves shall be positioned so that when closed, the valve body is isolated from the actively flowing portion of the piping system. Each pump shall have a swing check valve to prevent backflow through in operative pumps. In accordance with the criteria for water hammer control, check valves shall be of the type and strength required to eliminate water hammer damage. Plug valves shall be 100% port opening.

(3) Bypass Arrangement

As mentioned in Paragraph (1) above, sewage pumping stations shall have additional pipe, valves, fittings and couplings as necessary to permit bypassing of the station pumping units from a vault separate from the pumping station. This vault should be provided with a gravity drain discharging into the wet well. A valve should be provided in the drain line. This system shall also permit the recirculation of pump discharge back into the wet well for the purpose of scouring solids from the wet well and pumping them into the force main. The emergency pump around piping connections shall be accessible from grade. Submersible sewage pumping stations with a discharge head of 100 feet or greater must have an on-site manhole upstream of the wet well to serve as an emergency wet well for portable pump use. Care should be taken to locate this manhole, when required, out of traffic areas.

(4) Flow metering

Dedicated pump discharge flowmetering and chart recording devices shall be provided for all custom built-in-place stations and those package stations designated by the City. Where dedicated flowmetering equipment is not provided, provisions shall be made for utilizing portable flowmetering devices. The City utilizes ultrasonic flowmetering instruments which normally require a location with limited influence of valves, bends and fittings. For the devices employed by the City, five upstream and three downstream pipe diameters of straight pipe are usually sufficient. Additional length of straight piping is desirable.

(5) Pumping Units

Sewage pumps shall be 4 inch minimum size. All sewage pumps shall rotate counterclockwise as viewed into the impeller eye. Sewage pumps shall be centrifugal non-clog solids handling pumps capable of passing a 3 inch sphere. Pump motors shall operate on 460 volt, 3 phase, 60 cycle electrical service. Pump motor horsepower shall be sufficient to prevent motor overload under all possible conditions. Sewage pumps and motors shall be suitable for continuous duty.

(a) Submersible Sewage Pumps

Pump volute, impeller and motor housing shall be of cast iron construction. The pump volute casing and impeller shall be fitted with replaceable stainless steel wear rings to maintain sealing efficiency between the pump volute and impeller. The motor shaft shall be heat-treated high strength alloy steel or high strength stainless steel having a tapered end with keyway to receive the impeller. All nuts, bolts and screws shall be stainless steel. The motor shall be sealed from the pump by independent double mechanical seals. The upper mechanical seal shall run in an oil chamber and the lower mechanical seal shall run in the pumped liquid. All mating surfaces where watertight sealing is required shall be machined and fitted with a rubber O-ring. The machining of mating surfaces shall provide metal to metal bearing on sealing surfaces without crushing the O-ring.

(b) Dry Well Sewage Pumps

Pumps shall be of the vertical biltogether design. Pump volute, impeller, support base, suction elbows, seal housing/motor adapter and motor housing shall be of cast iron construction. The pumps volute and impeller shall be fitted with replaceable stainless steel wear rings to maintain sealing efficiency between the pump volute and impeller. The motor adapter shall have jacking screws to

permit adjustment of the wear ring clearances. The pump/motor shaft shall be stainless steel with straight fit impeller and with keyway. All nuts, bolts, and screws exposed to sewage shall be stainless steel. The pumps shall have double mechanical shaft seals, water lubricated. All mating surfaces shall be machined and sealed with gaskets or rubber o-rings. Where rubber o-ring seals are used, metal mating surfaces shall provide metal to metal bearing without crushing the o-ring.

(6) Pump Starters and Controls

Sewage pumping stations must be suitable for unattended automatic operation. As a result, the pump starting and stopping must be affected by equipment that is direct, reliable and easily understood by operating personnel. Pump starters shall be single speed, full voltage, non-reversing type.

(7) Pump Removal

From time to time sewage pump removal is required for periodic maintenance or overhaul. Dedicated lifting devices for pump removal will be provided for custom built-in-place sewage pumping stations. A motorized trolley hoist positioned over pump access openings shall be furnished. Package sewage pumping stations will not have dedicated lifting devices. Pump removal will be accomplished by a truck mounted boom hoist positioned over access openings. Submersible sewage pumps shall feature stainless steel guide rails and automatic cast iron discharge connection elbow system permanently installed in the wet well. Package wet well/dry well sewage pumping stations shall be furnished with a sufficient number of lifting eyes in the dry well top slab which can be used to assist in safe positioning of the pumps under the dry well access tube for a direct lift.

(8) Gauges

Pressure gauges where required shall be direct reading 4-1/2 inch dial, 1/2 inch connection in accordance with City specifications.

d. Emergency Station Operations

To ensure that utility power failures do not cause sewer system overflows, provisions to maintain sewage pump station operation with a standby power supply shall be made. The design engineer shall evaluate the following methods of dealing with utility power failures and select the method most appropriate for the project.

(1) Dual Feed Power Supply

Dual feed power supply shall be provided for the station if available from the power company.

(2) On-Site Power Generation

Where dual feed power supply is not available from the power company, a diesel engine driven emergency electric generator shall be provided. The unit shall be sized to allow both pumps to operate at the same time. Automatic transfer switch shall be provided to switch to emergency power on a power failure or a drop in any phase voltage to 70 percent of line voltage. A 275 gallon minimum aboveground diesel oil tank shall be provided in the generator room for fuel storage.

e. Miscellaneous

(1) Water System

Where water is available, a metered connection from the existing water system shall be made and water for the purposes of flushing and sewage pumping station washdown shall be provided. A 50 foot length of hose with spray nozzle, hose bib and interior backflow preventer shall be provided at a minimum. A water supply system shall be provided for all custom built-in-place sewage pumping stations. If there is no existing water supply system, a well and hydropneumatic tank shall be installed at custom built-in-place stations.

(2) Electrical Service

The electric service shall be 277/480V-3 phase - 4W. The service shall be sized to allow all station fixtures, equipment, and both pumps to operate together.

(3) Convenience Receptacles

120 volt, 1 phase receptacles with GFI shall be provided within the pump station buildings. One duplex outdoor weatherproof outlet shall be provided for the odor control unit and one duplex weatherproof outlet shall be provided for portable tools, lights, etc.

A weatherproof 480 volt, 3 phase, 100 amp receptacle will be provided on the building wall exterior to allow use of a portable emergency pump.

(4) Portable Generator Connection

Pump station buildings shall have a through wall 4 inch diameter pipe sleeve with capped ends to permit the passage of temporary power cables. Power from a portable generator can be delivered to the automatic transfer switch at the emergency generator connection lugs for stations so equipped, or at the station main breaker if emergency generator is not provided.

(5) Coatings and Painting

In general, all exposed construction materials and equipment shall be field painted or have some other form of field applied protective coating. Stainless steel, aluminum, PVC, brick and factory finished items are excluded. Painting unfinished materials shall be in accordance with the specification. Paint and other coatings shall be utilized as necessary to prevent corrosion, extend wear or promote easy to clean surfaces. Paint and coating systems used at sewage pumping stations must exhibit superior durability.

(6) Testing

The installation of mechanical and electrical equipment in accordance with these design standards requires, upon completion and prior to final inspection, testing to insure the standards are met and to maintain quality control. Electrical testing procedures will apply to all electrical equipment. Vibration testing procedures will apply to all motor or engine-driven equipment. Load bank testing procedures will apply to all standby generators.

(7) Autodialer

All pump stations must be equipped with an autodialer with telephone service to allow for telemetry. A Raco Verbatim shall be supplied at a minimum. Additional or substitute telemetry systems may be required as is deemed warranted by the City at the time of the design of the pump station.

(8) Final Inspection Checklist

Prior to sewage pumping station acceptance as part of the City of Brunswick Sewage System, a thorough inspection and operational check of the station is required in the presence of a representative of the City. A typical final inspection test procedure and checklist is attached to the specification. Each sewage pumping station design shall be submitted with an inspection test procedure and checklist tailored to the station.

4. Vibration

The pump station designer is directed to include vibration design and installation requirements in the Specifications.

4.0 CONTRACT DRAWINGS AND DOCUMENTS

4.1 Reports

For sewer mains larger than 8-inches, three copies of a preliminary report shall be submitted to the City. The report shall include a sketch of the preliminary layout and a summary of the design data.

4.2 Design Computations

1. Design engineers shall submit three copies of design data and calculations for all sewer projects. The computations shall be in accordance with methods presented in this manual.

2. The design data and computations shall include: average, peak, inflow and infiltration, and future requirements.

3. Design computations for all special structures shall be submitted. Where information pertinent to design, such as borings, has been collected, this information shall be submitted to the City. The locations of borings shall be shown on the plan sheets, and the boring logs shall be included in the Contract Documents. In addition, the City reserves the right to require borings and geotechnical information.

4.3 Specifications

Contract specifications shall utilize the City of Brunswick Specifications or, in the absence of City Specifications, the Frederick County Specifications will apply.

4.4 Contract Drawings

4.4.1 Preparation

Sewer main Contract Drawings shall be prepared on drawings separate from drawings detailing the road design. Separate drawings shall be used for each street.

4.4.2 Plan

a. Scale: 1 inch = 50 feet.

b. Method of Indicating Location

Generally, sewer mains and structures shall be located in Plan by dimensions from property markers or other well defined physical features. However, in areas where physical features are not available, coordinates of structures and bearings of sewer mains based on the Maryland Coordinate System NAD 83/91 shall be used.

c. Fittings

A list of all fittings required shall be shown on each drawing.

d. Contract Drawings shall include the property line surveys and all lot dimensions of the land bordering sewer extensions and shall indicate the names of the present owners of such property with the recording reference number of the deed, lot numbers, house numbers, subdivision names and block numbers, as well as existing rights-of-way or easements. When rights-of-way must be obtained, a right-of-way drawing for each property shall be provided, accompanied by a written description of each right-of-way.

4.4.4 Profile

Profiles shall be shown for all sewer mains. Profile shall be on same sheet as the Plan.

a. Scale

Scale of all profiles shall be 1 inch = 50 feet horizontal; 1 inch = 5 feet vertical. Sewer main profiles on straight streets shall be shown to correct scale. On curved streets, horizontal distances between structures shall be plotted, using length of street centerline between radial projections to structures. The true length between structures shall be shown by figures.

b. Road Grades

Approved established grades shall be obtained from the City. When such grades are not available, they shall be established by the design engineer and submitted to the City for approval.

The established grade (noted as top of curb or centerline) shall be shown. Where sewer main is located in present or proposed pavement or shoulders, the existing centerline grade of road shall be shown. Where sewer mains is outside pavement or shoulders for a length greater than 50 feet, existing ground over sewer main shall be shown and labeled.

c. Sewer Main on Fill

Where sewer main is to be constructed on fill, a profile of the undisturbed earth (at sewer main location) shall be shown.

4.4.5 Pump Stations

Sufficient details, plan views and elevations shall be shown for all pump stations, including architectural, mechanical, civil or site, electrical and structural plans and details. The scale of elevations and details shall be 1/4" = 1'-0". Slightly larger or smaller scale views may be used if more appropriate. Site plans should be shown at 1" = 10' or 1" = 20' scale.

4.4.6 Grinder Pumps

Grinder Pump locations shall be clearly shown on the plan view, with a table or chart identifying the depth, type, size and other pertinent details. The plan view shall clearly shown the location of the electrical cables and alarms, breakers and appropriate details.

4.4.7 Other Utilities

Other existing and proposed utilities shall be shown accurately and clearly in Plan and Profile.

4.4.8 Location and Design Information

A Location Plan, showing well known streets, at a scale of 1 inch = 200 feet shall appear on the first drawing of each set of Contract Drawings. A schematic layout of the proposed extensions to the sewer system and adjacent existing lines shall be shown.

4.4.9 Special Details

Structures of details not included in the Standard Details shall be detailed clearly on the Contract Drawings, preferably where the detail is located in Plan.

4.4.10 One (1) copy of the As-Built drawings on mylar plan sheets with the statement and Engineer's signature, as shown in the Appendix, shall be submitted to the Office of Planning and Zoning within thirty (30) days of completion and acceptance of the work by the City and on computer or GIS diskette in a format approved by the Office of Planning and Zoning.

GEO-TECHNICAL REQUIREMENTS FOR
UTILITY DESIGN AND CONSTRUCTION INSPECTION

PURPOSE

The following is intended to provide guidance to the engineer and contractor in their pursuit of the project and not to specifically dictate their activities.

DESIGN PHASE

Geotechnical services provided during water utilities design shall include the selection of boring and test pit locations, and the selection of sample types and intervals, the selection of field and laboratory test procedures, and the preparation of a geotechnical report. At a minimum, the report shall include the following:

1. Project overview.

2. Types of measures that will be needed to check stabilization of excavations and provide values of design parameters (lateral earth pressure distribution, allowable slopes).

3. Need for dewatering systems that may be needed and provide description of groundwater conditions over project limits of work.

4. Foundation preparation measures to be used.

5. Allowable bearing pressures, anticipated total and differential settlement, pipe bedding requirements, etc., to support design loads.

6. Backfill material characteristics required.

7. Estimated volumes of borrow.

8. The level of compaction needed to satisfy design criteria and methods of achieving this compaction through appropriate combinations of compaction equipment, water contents, and lift thicknesses.

9. Pavement design considerations.

10. Pavement reconstruction considerations - address need for road reconstruction around excavations.

11. The basis that will be used for field evaluation of material suitability, adequacy of compaction, acceptability of shoring, etc.

12. The potential sources and magnitudes of uncertainty in geotechnical conditions.

13. Guideline construction specification with respect to geotechnical requirements.

14. Potential for encountering sink holes and mitigation measures for avoidance.

15. Soil boring logs within area of construction and stormwater management facilities.

16. Impact on nearby wells and springs and mitigation measures.

CONSTRUCTION PHASE - FIELD IMPLEMENTATION OF GEOTECHNICAL REPORT RECOMMENDATIONS

Implementation of geotechnical report recommendations and design requirements is critical to satisfactory completion of the project. The following guidelines are to be followed by the project inspector.

1. The design phase geotechnical engineer should be involved during construction. (Depending on the size of the project, this involvement could range from telephone consultation to on-site inspections. However, geotechnical expertise should be available during construction.)

2. A qualified testing laboratory should be engaged.

3. The geotechnical report prepared during design should be provided to the inspector prior to construction. Both the inspector's office and field personnel should be familiar with all aspects of the report, including, but not necessarily limited to the following:

   a. Existing conditions.
   b. Feasibility of using materials from trench for backfill.
   c. Appropriate compaction methods for excavated materials.
   d. Procedures for selecting and approving borrow sites.
   e. Appropriate compaction methods for borrow materials.
   f. Recommendations for when select materials should be used.
   g. Appropriate methods for compaction of select materials.
   h. Appropriate methods for monitoring 'c', 'e', and 'g' above:
      (1) Sampling.
      (2) Laboratory testing.
      (3) Field testing.

4. In consultation with the design geotechnical consultant, the resident inspector should develop a written plan for implementation of the recommendations of the geotechnical report. This plan should include the following:

   a. Identification of the person responsible for insuring adherence to geotechnical report recommendations in the field. Because immediate field decisions are usually required at some time during construction, this person should be well grounded in the subject of backfill materials, methods and compaction, and at least knowledgeable enough to recognize field conditions that do not conform with the geotechnical report and to seek necessary assistance.

   b. Establishment of general criteria for use by the field representative in meeting the requirements of the geotechnical report:
      (1) Frequency of standard Proctor determinations.
      (2) Frequency of soil density determinations.
      (3) Criteria for using visual characteristics and soil consistency for spot determinations of backfill material suitability without consulting geotechnical experts.
      (4) Criteria for using visual characteristics and soil consistency for spot determinations of compaction suitability without soil density determinations.
   c. Establishment of procedures for detailed record-keeping using a daily

inspection report form. This form would require that each of the following be addressed:

(1) Conditions encountered.
(2) Help sought from supervisors, geotechnical engineer, etc.
(3) Location of field tests.
(4) Weather conditions.
(5) Notations on visual and manual observations.
(6) Exceptions to geotechnical report recommendations (field decisions).